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GEOLOGY AND ECONOMICS[1]

DURING the century which has just closed, the various branches of natural science, botany, zoology, geology and their relatives, having earlier completed their childhood, attained to the well-rounded development of maturity Their broad truths were given clear expression, they were widely apprehended, and they became the foundations of various inventions and applications of far-reaching influence upon human welfare Geology, although closely bound up with agriculture, has, nevertheless, been especially concerned with mining And justly so, because its contributions to the art of mining have been no more than a filial return, since mining as practised in the middle ages was the parent of geology Until recent years geology's services to the industry have been chiefly rendered in spreading sound and reasonable ideas regarding the nature and distribution of the useful minerals, in solving the perplexing structural questions affecting their occurrence, and in facilitating the discovery of new fields.

The problems of the production of the metals and non-metalliferous substances, as we know them to-day, are of quite recent growth. High explosives, efficient engines and pumps, steam shovels and the like are all not so old as many men who are still living. They have so greatly reduced costs that practically a new world has opened to the miner. Not only on the surface or near it has he been able to work, but the depths have become accessible, and where the value of the ore justified the ef-

[1] Presidential address before the New York Academy of Sciences, December 19, 1910.

fort, no floods of water have sufficed to keep him out

These successes coupled with ever-expanding markets have until recently directed attention almost wholly toward discovery and production But the last ten years have brought a further change We are now less concerned about new discoveries than about the maintenance of old ones We are not altogether intent on production, but are much given to forecasting and husbanding. From being solely an aid to the miner, the active worker, the producer, geology has become the colleague and helper of the economist, the statistician and the philosopher.

Like all other changes in fundamental points of view, this one has not come with absolute suddenness As far back as 1879 certain geologists and engineers began to raise and discuss the question of the duration of the Pennsylvania anthracite. In 1894 the late Richard P Rothwell, long the able editor of the *Engineering and Mining Journal*, gave these coal fields a future of 70–100 years Thus for over thirty years the question of their death has been a very live one Even earlier the future of the coal-fields of Great Britain came up for discussion A parliamentary commission was appointed in 1866 and reported upon the question in 1871. For forty years anxiety has prevailed regarding the continued production of our petroleum wells, and naturally so The very means of production of this useful source of heat and light starts a train of thought along the lines of its permanence.

Some ten years ago, the question of our reserves in iron ore began to excite interest. Mr. Andrew Carnegie gave most forcible expression to the feeling of alarm in his rectorial address in 1902, at the University of St. Andrews, Scotland. Mr. Carnegie was known from one end of the world to the other as one of our greatest iron-masters and his words made a profound impression In his address he assigned us only enough first-class ore to last for sixty or seventy years, and only enough of the inferior grades for thirty years thereafter. We all trembled for some years with the prospect of seeing our greatest industry in the production of metal, disappearing within a century Many thoughtful people began to wonder what would become of us with its extinction.

I have thought, therefore, that it might be not without interest if we take up this evening the more important of our metals and pass in review some of the fundamental facts of their production, the yield of their ores, the foreign sources, the future probabilities and the effect upon the civilization of our own and other lands which would result from their curtailment. In a word, we may for a time discuss geology and economics.

The iron industry in the United States took its rise in the colonies along the Atlantic seaboard—and at the outset was based upon the magnetic ores and brown hematites there occurring. For one hundred and fifty years its growth was slow. In the decade of the forties and fifties of the past century it had spread to the Adirondacks and in the fifties began its development in the Lake Superior region. Not until after the close of the civil war and the resumption of peaceful activities did this great industry manifest its possibilities. With improved facilities of navigation which placed Lake Superior in easy communication with the coal-producing states of Pennsylvania and Ohio, the iron-ore-producing states of Michigan, Wisconsin, and later Minnesota, came rapidly into prominence. In somewhat slower growth Alabama, during the seventies and eighties gathered headway. At present four fifths

of our ore supply comes from the three Lake Superior states, and three out of the four fifths from Minnesota alone. Alabama, Tennessee and Georgia together yield one tenth and the remaining tenth is divided among a dozen or more other states, of which New York is the leader. Since 1880 the total has increased about sevenfold and Pennsylvania, then the source of about one quarter the supply, now yields approximately one and one half per cent. Minnesota, now the great source of ore, only entered the lists in 1884, and only began to utilize its present great mines about ten years later.

Thus in the brief course of thirty years there have been very great rearrangements not only in geographical sources of supply, but still more in actual amount of output. In normal, prosperous years the annual production is somewhat more than fifty million tons of ore.

But there have also been other changes not less striking. In early days and in remote situations only the richest ores could be mined. Magnetites for example in the lump from the Adirondacks afforded over 60 per cent. metallic iron. Specular hematites from the Lake Superior districts necessarily yielded 65. For some years no one regarded them with respect if they contained less. Red hematites from Alabama afforded forty-five to fifty. The minor ores near the furnaces were often much lower—but they may be passed over for the moment in emphasizing the larger features. Magnetites in the Adirondacks are now concentrated before shipping and in instances two and one half to three tons are condensed to one of 65 per cent. tenure. The crude ore carries 33–35 per cent. During the early years of the present decade the general average yield of Lake Superior shipments fell off about one per cent. per year—so that now the soft ores, so called in contrast with the hard lump specular of earlier days, range somewhat above 50 per cent. Alabama ores, once 45 to 50, now are very uniform at 36 to 37. So far as the brown hematites are concerned, which in the form of lumps, crusts, pipes, etc., are distributed throughout ochres and clays, the percentage of available iron in the crude ore is lowest of all. We wash from eight to ten tons of crude in order to get one ton of concentrates of say 40–45 per cent. in iron, and under favorable circumstances may treat much lower raw materials. Soft magnetites in Pennsylvania, which on the richer outcrops gave 45 to 50 per cent., are now dug in very large amounts with a yield of 43. If we take the total production of ore in the United States and the total production of pig iron, we find the yield in the large way to be about 50 per cent.

In order to gain some idea of the comparative merits of these figures when set alongside the percentages in the ores produced in other lands, a few cases may be cited. Germany in 1907 produced 27,700,000 tons of ore, exported nearly four millions and imported eight and one half millions. Of the local production three quarters were obtained from Elsass, Lothringen and Luxemburg, whose percentage in iron ranges between 30 and 40 and is on the whole not very different from Alabama's present percentages of 36–37. Germany's imports, of course, range much above these figures, else the ore could not stand the freight charges from mines in such remote countries as Sweden, Spain and Algiers.

Great Britain produced in 1907, approximately, 15,000,000 tons, of which about three quarters were the so-called impure carbonates yielding 30–35 per cent. iron. One ninth of the total was red hematite at 50–55. The general average would be somewhat less than that of Alabama. Im-

portations of richer ores, especially from Spain, helped to raise the furnace yield.

France in 1908 produced 10,087,000 tons, of which 88 per cent was mined in French Lorraine of the same type as the main German supplies The ore ranged from 33 to 40 per cent—again not far from the Clinton ores of Alabama We are justified, therefore, in saying that the largest part of the output of the next three producing countries of the world is about the same as the lowest grade of lump ore, which can be profitably mined under present conditions in the United States. When, therefore, we come to estimate comparative reserves we must realize that in the Lake Superior region—our greatest producer—we pay no attention to-day to ores, which are, nevertheless, much richer than those of Great Britain and continental Europe

In the opening sentences I spoke of the anxiety which was felt a few years ago regarding the reserves upon which the industry would of necessity rely for its future I mentioned Mr Carnegie's remarks in 1902 at the University of St Andrews But he was not the only one who discussed this question and now in referring to one or two other forecasts, I think you will have in mind some of the fundamentals which establish a correct point of view

In 1905 Professor Tornebohm, the eminent and greatly esteemed former director of the Geological Survey of Sweden, assigned to us a reserve of only one billion and sixty millions of tons Obviously, at an annual production of over fifty millions this reserve would only last twenty years. The future thus looked still darker than when seen through Mr Carnegie's spectacles Much opposition arose at once, however, to Professor Tornebohm's data, because from them had been omitted the red hematites of Alabama, which can be very accurately estimated and which of themselves are thought by competent observers to have a half billion tons for the future. Additional modifications must also be introduced when we properly appreciate the downward tendency of workable percentages The lower the percentage of iron which we require in the product of our mines, the greater the amount of ore which at once becomes available This is peculiarly true of iron, because of its very wide, general distribution

In 1907 in anticipation of the International Geological Congress of 1910, which was to be held in Stockholm, the Swedish committee of arrangements began the preparation of a series of estimates of iron reserves in all the countries of the globe. Geologists familiar with local conditions were requested to prepare the figures each for his own country It fell to the speaker to start the collection of American estimates and much aid was afforded by several of the largest companies owning reserves Shortly thereafter, however, the interest in the conservation of natural resources sprang up and Dr. C W. Hayes, of the United States Geological Survey, was empowered to use all the resources of this great organization in assembling data on iron. In this way figures as reliable as can be expected are now available. We learn from them that we may consider three and one half billion tons of fifty per cent ore as assured in the Lake Superior region Of this great total three billions, one hundred millions are in the Mesabi range of Minnesota At thirty millions of tons per annum, the present output of Minnesota, we have a reserve for a century

On the other hand, if we drop to 40 per cent. or slightly below, still, however, remaining a few per cent above the Alabama grade, the drill holes show above depths no

greater than those already reached in some mines, two or three hundred billions of tons of siliceous hematites, giving amounts practically inexhaustible.

In the Alabama ore beds we feel assured of five to six hundred million tons of the grades now utilized and there may well be twice that number. The conservative estimate would afford enough to last at the present output of that state longer than a century. In addition there is much reason for thinking that there may be two or three times as much

Speaking for the country as a whole, we may say that there is an assured and demonstrated supply, at present rate of output and at present percentage of yield, for about a century There is, furthermore, a less accurately measured but still very probable addition, when we allow for lower grade but still practicable ores, which will be sufficient to last at present rate of production for fifteen hundred years to come

If, however, production increases, as indeed it may with a rapidly growing population, and if in this way heavier and heavier drafts are made upon even this great reserve, where shall we look for more? There may be some new discoveries within the United States, but at present it is impossible to speak definitely of them. We may ask if there are other supplies in neighboring lands To this question we may answer yes. Along the north shore of Cuba, toward its eastern end and near the sea, three areas of what formerly appeared to be a barren, ferruginous soil have been discovered and tested, so that we now know that there are two to three billions of tons of a very pure iron ore, which, when deprived of the large percentage of water which it contains—a cheap and simple process—will yield from 40–45 per cent. iron. This variety of ore already begins to enter our ports and the deposits will undoubtedly contribute in no unimportant way to the output of our furnaces.

The report of the International Geological Congress has shown further that in Newfoundland there are quite probably more than three billions of tons of red hematite, whose present yield averages 54 per cent. From Brazil, moreover, in the state of Minas Geraes, but pretty well back from the coast and not yet opened up by rail, as estimated by Dr O A Derby, there are from five to six billion tons of 50–70 per cent ore awaiting the drill and the steam shovel Ore from Brazil faces a long sea voyage, but the grade is rich and the iron masters of this and other countries are looking upon these deposits as well within the possibilities of the future Ocean freights are kept at very reasonable rates in later days and once on a steamship even so low-priced a commodity as iron ore, if of good percentages and cheaply mined, can be taken relatively great distances This is demonstrated by the shipment this year from the mines of Kiruna, 112 miles within the Polar Circle in Lapland, of 300,000 tons of ore, 113 miles to the Norwegian coast by rail, and over 4,000 miles to Philadelphia by sea, with no great prospect of a return cargo. These shipments also demonstrate that we are not without the range to which European ores may be shipped when exceptionally rich Some portion of the vast ore body of Kiruna, with its demonstrated 500 millions of tons of 65–69 per cent. ore will also reach American furnaces.

But even were our actual ores of present grade to become exhausted, iron as a metal would not fail. The basic rocks with their low percentages still remain. The traprock of the Palisades contains 7–8 per cent. of metallic iron, a value that is far above the general yield of our copper ores in the red metal.

Iron, therefore, will never fail. It will probably not change in its general relations to modern conditions for a very long time to come, so far as its ores are concerned. We may have greater anxiety about the supplies of coking coals than about the iron ore, but there are always such possibilities of improvements or changes in processes that no one can justly give way to unqualified forebodings.

Copper is the metal generally considered next in importance to iron. It is a very old one in the history of the race. The bronze age, you will recall, preceded the iron age. Prehistoric man in Europe solved the mixed metallurgy of copper and tin before he learned the smelting of iron. Prehistoric man in America found native copper on the shores of Lake Superior and passed it in trade a thousand miles from its home. As a cherished possession it constituted his ornaments while he lived and it was buried with him after he had died.

Among the moderns, copper is most extensively employed in brass, but as a conductor of electricity it finds year by year increasing applications in the purest condition in which the metallurgist can supply it. If at home or in your office you look around your chair or desk you will be surprised to find how universally employed it is.

Greatly stimulated by the development of electricity in later years the production of copper has advanced by leaps and bounds. At present the United States are the heaviest producers, with Spain following next, but only yielding one eighth as much. The United States furnish over half the total. In 1850 the United States yielded 728 tons, in 1900 over 303,000 and in 1908, 471,000. Meantime in 1850 the price of copper was about 30 cents per pound. Its lowest point in recent years was nine cents in 1894. Its highest, 25 cents, was attained in 1907. We may each of us imagine the variation in the profits of a mining enterprise as between 11 cents a pound and 15 cents, let alone 20 or 25 cents. Mining costs, smelting and freight charges, show no such variation, so that with rising prices profits greatly increase. Indeed, few of the metals have such extraordinary ups and downs as does copper.

In its ores the yield varies greatly. On Lake Superior, where the native metal is distributed through ancient lava flows in little pellets, leaves and sheets, it has been profitably mined and produced through periods of years, when it constituted but three quarters of one per cent. of the ore. The general run is, however, one per cent. and above. If we recall that in a ton of 2,000 pounds one per cent. is 20 pounds, and three quarters of one per cent. 15 pounds, and if copper is selling at, say, 13 cents, the mining manager must break down, hoist, concentrate with attendant losses, and smelt an ore worth less than two dollars for all the metallic contents which it contains. We can thus gain an idea of the close and economical work required and the ability demanded of a manager. As the price rises the profits greatly increase, and temporarily idle mines are brought within the widening remunerative zone, and are quickened into life. As the price falls, the mines dangerously near the line close down and production ceases. The lowest cost of production claimed is from the low grade and very large ore bodies of the west and is placed at or about eight to nine cents per pound laid down in New York.

In copper ores outside of the Lake Superior region, we usually find the metal in composition with sulphur. The ores as they come from the mine may be rich enough to go directly to the smelter, or they may require concentration before the

grade is sufficiently high. The ores which are directly smelted reach the minimum of copper in the Boundary district of British Columbia, but associated gold and silver raise the value per ton above four dollars. Copper ores yielding copper alone were smelted at Ducktown, Tenn., during long campaigns at a little less than 2.5 per cent. In earlier years and in many mining districts ores as high as 20 per cent. were found, rarely even higher, but they in time were exhausted and five per cent. would be quite rich for day in and day out averages.

These statements will serve to establish a point of view and likewise afford a standard of comparison. What is the outlook for the future of copper production?

We can not predict copper with the certainty of iron. It seldom appears in bedded deposits which can be measured. In the deep mines we can not always see ahead for more than a year or two. In some mines we know from exceptionally complete development, of twenty years' supply. But the great advance in copper mining has been the entrance of relatively low-grade ores into the productive field. The wall rocks of ten years ago have become the ores of to-day. Where we find in porphyries or schists copper sulphide disseminated in fine particles or as coatings along crevices, and in sufficient richness to yield two to two and one half per cent., throughout very large bodies, it can be mined very cheaply and concentrated in enormous quantities so as to return a safe margin. If the ore lies near the surface, steam shovels make excavation extremely low in cost. The huge pits and open cuts of this type of mine in the west are now among the great sights for the traveler. Mills whose insatiable crushers take as much as eight or ten thousand tons per day are no longer unknown. The drill blocks out the ore long before mining begins, and reserves can be estimated more closely than in the vein mines.

If a mine is called upon to furnish a mill with 2,000 tons per day and we allow 300 working days in the year, 600,000 tons must be supplied per annum. For a life of twenty years, a time practically demanded of such an enterprise to justify the great expense of installation, at least 12,000,000 tons must be shown by the drill before the enterprise can safely begin. If we expect to mine three times this amount per day we call for three times as much ore. These figures, large as they may seem, are not beyond the estimates of ore bodies as now blocked out in several places in the west, and even with these great demands, twenty years supply and even more in instances have been demonstrated.

Let us now imagine again a 2,000-ton daily output of say 2.25 per cent. ore, of which the mill saves two thirds, or 30 pounds of copper in the ton. The output in copper per day will be 60,000 pounds, or 30 tons and for the year 9,000 tons. Should three new companies start up with four or five times this output, 36,000 to 45,000 tons will be added to a yearly supply, which in 1909 was 552,668 tons. We see great need of a growing demand in order that these vast contributions may be absorbed. Yet I have made no unreasonable assumptions nor have I overstepped the practical certainties of the next few years.

How long will our copper hold out? Mines come and go, and for the immediate future there will certainly be no scarcity. Copper does not oxidize as readily as iron and is not lost. The world's stock steadily accumulates. But twenty years is not a long look ahead. Are there new countries which will be producers? Some of the old mines in Europe are now no longer great sources of the metal.

We do know of possibilities in Alaska that will add some contributions We know of new or recently opened ore bodies in Peru, Bolivia and Chile that promise well We hear of very large deposits in the southeastern corner of the Congo State, once worked by the ancients, now revived by the moderns and possessing large reserves of 15 per cent copper ore The Cape to Cairo railway will give them great impetus For the immediate future there is no lack, but if we look fifty years or a century ahead we can speak with less confidence In a general way we may say that probably new discoveries will, for a time at least, more than keep pace with demands But when we look fifty years into the future we are not so certain It behooves the producers to use no treatment of an ore except a careful and economical one If tailings and waste from our mills now contain one third the copper in the original ore, they should be impounded and kept from being washed away by floods, against the possible call of the future We dare not say that they will never be within the ranges of profitable treatment even though their low percentage places the copper beyond reach to-day The copper situation is not one to excite anxiety, yet it is also one not to encourage extravagance

Following copper we may take up lead and zinc, which are the next metals in amount of production Of the three, zinc is the least in total tons and in total value We may gain some idea of the relations from the small table given below in which zinc is taken as unity and the figures relate to 1908

	Amount	Value	Price per Pound
Zinc	. 1 0	1 0	1 0
Lead	1 6	1 45	0 9
Copper	2 46	7 0	2 8

Thus we see that the lead production is one and three fifths that of zinc, and the copper is two and one half times, that the lead is about one and one half times the value of the zinc, and the copper is seven times, and that zinc is worth more per pound than lead and only about one third as much as copper. The red metal is not only produced in greater amount, but is worth more per pound and in the aggregate than both the others taken together.

Among the nations of the world the United States has become the chief contributor of lead and yields year by year proportions varying from 27 to 33 per cent. of the total The next country is Spain with about two thirds as much, and Germany follows with three fifths

In this country the state of Missouri is the heaviest contributor and is responsible for practically 40 per cent of the total. Idaho is next with about 32 per cent and Utah follows with 13 to 14 The western lead all carries silver The precious metal is an important factor in the value of the product When we come to forecast the future it is not possible to see more than a few years in advance or to speak in more than a general way The miners would be glad to be assured of reserves of ore for a goodly period of years, but it is seldom possible or practicable to demonstrate their presence Operations necessarily continue with a few years' supply blocked out in advance of the actual mining and the hope is maintained that more will be found. Very often the expectations prove justified. We may therefore in a measure forecast future experience somewhat by the past In the Missouri lead region mines have been operated for forty or fifty years, not on so large a scale at the outset as now, but continuously For some years at least no change may be anticipated In Idaho the lead ores are now known to continue to

depths of nearly 2,000 feet beneath the overlying surface and to be holding out without essential change in character. In Missouri, however, the mines never have been very deep, that is over three or four hundred feet, and the compensation comes in wide horizontal extent

Some of the old time heavy producers have greatly declined Nevada, once an extremely important source of lead, is now a comparatively small contributor Colorado, in former years our chief source, has dropped to only a third of its one-time yield, and yet the total of the country has gone quite steadily on The fall in the price of silver was a hard blow to the western lead miners and naturally not only cut off their profits, but raised the necessary percentage of metal in the ore

If we look ahead for a century or some such long period, we may not feel assured that production can be maintained at present rates There may, of course, be new discoveries in lands not as yet fully explored Being distant from present centers of consumption as they necessarily would be, their entry into the markets would imply higher prices so as to meet the charges of freight

On the other hand, lead is a metal which oxidizes or changes very slowly In its applications in the metallic state it tends thus to accumulate unless lost in use, as in the case of shot and bullets It is extensively employed in the manufacture of paint and in this form is of course never recovered About two per cent of the entire output is destroyed to give us white and red pigments

It behooves us on the whole to be careful in the use of lead and to avoid, when possible, its unnecessary sacrifice

Zinc is a metal of comparatively late introduction into commerce in the large way. Although known for centuries, it has found its chief applications in the last sixty years There was no zinc mine in the United States until approximately the year 1850, and from the Missouri region whence we now obtain our chief supplies, the really serious contributions began about 1870 Lead, indeed, was mined and prized long before this, but the associated zinc ore was thrown one side on the dumps In the west the same experience continued until much later Zinc was a nuisance in the metallurgical treatment of lead and even the lead was sought and smelted either because of its own silver contents or because it made possible the treatment of other refractory silver ores In the metallurgical work the zinc was volatilized or slagged off and was lost Indeed, one of our most serious metallurgical problems has been the successful treatment of lead-zinc ores and many investigators have addressed themselves to its solution Now that anxiety is beginning to manifest itself regarding zinc supplies for the future, the desire to save it is stronger than ever.

Zinc, however, is a peculiar metal and because of the exigencies of its treatment its ores must possess greater richness and greater purity than those of other base metals Thus in the case of copper a ten per cent ore is in later days phenomenally rich, and as it can be smelted in a shaft furnace the presence of iron or lime or other bases that make fusible slags is an advantage But zinc ores, perhaps after preliminary roasting, must be reduced and the metal must be volatilized at a high temperature from a small charge in a retort The presence of fusible bases destroys the retort and the bases are therefore debarred beyond certain small percentages Thus it happens that a forty or fifty per cent. zinc ore might be valueless if contaminated by iron or lime beyond a narrow margin While almost any con-

ceivable mineralogical aggregate that contained ten per cent of copper would be a very valuable ore, a zinc-bearing aggregate with four or five times as much zinc might be unsalable

Suppose we compare them from another standpoint Copper ores, if at all profitable, are worth about so much per unit of copper, that is, so much for each per cent While there is some variation yet the contrasts as among three per cent, five per cent and ten per cent ores are much the same as the ratio of the per cents to each other But if we think of a zincblende ore or concentrate of 60 per cent as the standard of richness, a fifty per cent ore is not worth five sixths as much, nor a forty per cent ore two thirds On the contrary a forty per cent ore might be entirely unsalable. As the zinc decreases other deleterious bases take its place and a worthless mixture soon results Zinc is in many ways the most peculiar of the metals and when we come to deal with its profitable treatment analogies with other metals fail

In 1907 the United States were the chief producer of zinc among the nations, but, as a rule, Germany leads, followed by this country and Belgium in the order named In later years our output has varied from 26 to 30 per cent of the total As a rule Germany is 2–4 per cent in excess of us and Belgium is 4–5 per cent less

In America, Missouri is the chief source of zinc Its production from the mines was in 1908, approximately one half the output of the entire United States New Jersey follows with somewhat over one quarter the total, while all the rest are much smaller

The Missouri ores as thus far produced have been obtained from comparatively shallow depths They extend lengthwise and sometimes laterally to greater dimensions than vertically While it is not beyond the possibilities that lower lying deposits may be discovered, since zinc ores are found in Arkansas in strata of lower geological position, anticipations of this reserve have not as yet been demonstrated on a large scale Kansas, Oklahoma and Arkansas, the states neighboring to southwest Missouri, also have some zinc ores, but they are not of great importance, southwestern Wisconsin is a very old mining district and has many small mines, which were earlier worked for lead. They have been revived for zinc in later years and are now an appreciable but not great factor They may develop somewhat more extensively and may last for a goodly series of years, but the mines are relatively small and are wet, so that exploration does not go very far in advance of mining.

In New Jersey the future is best forecast of all For thirty or forty years there is no occasion of anxiety Yet thirty or forty years pass quickly and then we must prepare to look for other sources To make the zinc blende of the Rocky Mountain region available, an increase in price is practically necessary, otherwise the metal can not stand the freight charges There is zinc ore in the west but to what extent we can not well say It has been avoided rather than sought in most of our mines. Yet we do note symptoms of attention to it In Butte, Montana, efforts are being made to concentrate it Shipments of oxidised ores have been made from New Mexico for some years past Until recently large amounts of peculiar appearance seem to have been overlooked at Leadville, Colorado. They promise to be an important resource. A government commission has reported upon the occurrence of the metal in British Columbia in the hopes of utilising the ores. From Mexico, too, we learn of explorations for zinc. Conditions are changing in the case of this metal and

more and more it is certain to be brought from remoter localities But when we look a long way ahead, say for a century, we can not feel free from anxiety. This condition of mind is even more prominent in Europe than in America. The waning of the famous old mines near Aix la Chappelle, and the apprehensions felt regarding other sources, have led to a world-wide search. Zinc ores, for example, now reach Hamburg from the Pacific shore of Siberia, and as other discoveries are made, additional points remote from present smelting centers are likely to be shippers, provided that transportation is by water Nevertheless, all these new conditions call for advances in price and before many years zinc bids fair to take the upward course

The precious metals, silver and gold, are the only other two which we may pass in quick review Silver is a less profitable object of mining than it was twenty years ago, and yet with the improvement of processes of extraction and with the great development of the output of copper and lead in which it is a by-product, the fall in its price of the early nineties has been less disastrous to the amount produced than one might have supposed. Our maximum output was reached in 1892 when it was 63,500,000 ounces valued at $55,662,500 In the same year about 1,600,000 ounces of gold were produced valued at somewhat over thirty-three millions of dollars. In 1908 we are credited with approximately fifty-two and a half million ounces of silver, valued at twenty-eight million dollars. Gold, meantime, with the fall of silver, has advanced to 4,574,340 ounces, valued at $94,560,000.

In the United States we have now comparatively few distinctively silver mines. Among them Tonapah, Nev., has been chief. Mexico is the particular home of silver, but the remarkable district of Cobalt, Ontario, has given great present importance to Canada. In our own country we must expect the white metal to share the fortunes of the copper and lead with which it is chiefly produced As influencing its future, copper is a more serious factor than lead, both for the reason that Missouri lead contains little if any silver, and because western copper ores display greater reserves than do western lead ores. As sources of silver there were in 1908 no very great differences among Montana (a copper-silver state), Colorado (a silver and lead-silver state), and Nevada (a silver state). Utah (both a lead-silver and a copper-silver state) afforded about five sixths Montana's output, and Idaho (a lead-silver state) about three fourths Montana's,[8] Arizona (a copper-silver state) follows after a long interval, and the others are much smaller

As an indication of relative magnitudes, while the output of the United States was placed at 52 5 million ounces in 1908, Mexico afforded 72 6 and Canada 22 millions Australia with 17 3 follows and then Peru with 7 2 millions. A metal with so high a value as silver will stand transportation from remote points, and although the production in one country or another may fluctuate, the world's supplies are not likely to be seriously affected for many years. Silver is largely used in the metallic state, and, being resistant to change, it tends to accumulate. Photography is the most destructive industry to it, and when once employed in this art, it is practically lost

[8] In ounces they range

Montana	10,356,200
Colorado	10,150,200
Nevada	9,508,500
Utah	8,451,309
Idaho	7,558,300
Arizona	2,900,000

Gold is mined for itself alone to a far greater degree than is silver. Thus in this country in 1908, almost 93 per cent. of the gold was produced without regard to other metals and only 7 per cent. was obtained with copper and lead, whereas about 60 per cent. of the silver was produced in association with the base metals. Gold in later years has increased in amount of production beyond all previous experience. The steady and scientific digging and washing of low-grade gravels are, in the long run, more productive than the rich skimmings of the early California, Australia and Klondike placers. The world's total of 444 millions of dollars in 1908 was in excess of any previous year. The Transvaal furnished the most, nearly 146 millions. The United States followed with 96 millions, Australasia yielded 72.5, Russia nearly 40, Mexico, 24.5, Rhodesia, 12.2 and British India, 10.4. All the rest were under 10. The countries mentioned supply about 90 per cent. of the total.

In the United States 28 per cent. of the gold comes from gravels and these are the least permanent of the sources of the metal. With their exhaustion the output will decline. In the deep mines there are signs of waning output in some districts. In our own country new districts have come to the front from time to time to give on the whole a steady increase in output for forty years past. So far as the future is concerned, however, the ups and downs of any one or of several countries make slight difference in the world at large. Gold can be readily shipped from point to point and the place of its production is a comparatively small matter.

Like silver and to an even greater degree it resists chemical change, so that the world's stock constantly augments. No very important portion is permanently lost in the arts.

Gold and silver are so extensively employed in coinage that they have received more attention at the hands of economists than have any other metals. Gold in later years, with its increasing production has led to much philosophical speculation. The establishment of it as the monetary standard and the elimination of silver from this position have occasioned some of the most heated political controversies in the history of our country. Into these a geologist is not competent to enter. We all probably realize from old-time experience how easy it is to become befogged. But the geologist can say that for some years to come the gold production will undoubtedly be maintained. And that while the Klondike and Alaska may wane, Siberia will increase.

We may now briefly summarize the main facts affecting the six metals which have been passed in review. It will then be possible to draw some general conclusions. Of iron ore there is no lack, nor need any one be apprehensive regarding the supply of this metal, but before very many years have passed the yield of the ore will have decidedly declined. While the falling off will be gradual, it will undoubtedly tend in the long run toward forty per cent. This change is in itself important because, unless otherwise neutralized it will raise the cost of production. It makes necessary the melting of more barren materials in the furnace, so that the consumption of fuel rises with respect to the amount of iron produced. It means also the mining and freighting of an additional burden which yields no return. From whatever point of view we regard it, other things being equal, the cost of production rises. The great reserves of lower grade ore than at present mined are in the Lake Superior district. They are siliceous ores, and will require in smelting the admixture either of limestone

or of other iron ores high in the bases. The Clinton ores of Alabama are of this type and except for the unfortunate percentages of phosphorus which they might add to Lake Superior ores, they would doubtless make an advantageous mixture with the latter. But the southern ores are remote from the northern. In order to meet them at or near the supplies of fuel a long railway haul would be necessary. While this is not impossible, it would add to the cost so greatly as to be highly improbable. There is one further consideration. The greater part of our pig iron is used in the manufacture of steel. For this purpose in the two processes most extensively employed hitherto, we need, respectively, either a very low or a fairly high percentage of phosphorus. If our irons are in between, and like the church at Laodicea, neither hot nor cold, they have been ill-adapted to steel manufacture. Unless the growth of the open-hearth process introduces great changes, the mixture, therefore, of southern basic ores and northern siliceous ones is not altogether promising for this reason.

The greatest cause of apprehension as regards present processes of iron manufacture lies in the supply of coking coal. We have built lofty furnaces, and in their use we place upon the fuel as it progresses downward in the furnace a heavy load of overlying ore and limestone. We need a very strong coke to stand up under the burden. The coals which yield these high-grade cokes are found in a small portion of the total coal-bearing area, and the life of the supply is one of the very serious phases of the present situation. I do not know what the amount of reserves may be.

While these physical and chemical factors operate to increase costs, there is always the possibility of improved processes and of greater efficiency to keep them down. The improvement oftenest in people's minds to-day is the utilization of water powers to generate electricity, which in turn may supply heat. Now, in a blast furnace smelting iron ores, one third the fuel is employed in reducing the iron oxide and two thirds in developing the necessary heat for the reaction. Were we able with water powers to economically furnish electricity and from it derive the necessary heat we might save the two thirds of the present amount of required fuel. We might reduce costs. The remaining one third of the fuel we should always need but it is possible that poorer grades than high quality coke might answer. The saving would lie, of course, in the difference between the cost of the fuel and the cost of the electric current, provided the latter could be furnished more cheaply than the former.

The water powers in our own country or at least in the more thickly settled portions of it, have not failed to attract attention, nor have they gone altogether unutilized. The more conveniently situated ones are already harnessed to the dynamos. But in countries like Norway and Sweden, where there are large water powers still available, where there are rich deposits of ore and where coal fails, the applications of electricity to iron smelting are likely to be first worked out successfully. Data may be furnished in the life-time of many of us, which will cast light upon these improvements in their world-wide relations.

The only other apparent possibility of reducing costs lies in the labor charges. Wages at present are not unduly high, and unless the increasing population of the country brings to pass an inevitable struggle for existence, which will cause the greater subdivision of tasks at lower proportionate returns or unless the general reduction of expenses for subsistence makes lower wages possible, there would seem to

be slight prospect of change in this item. In any event the reductions from this cause can not compensate the falling off in the yield of iron as foretold above.

Suppose iron goes up in cost—other conditions of our daily life remaining the same—transportation and all manufacturing based on machinery would become more expensive, and less freely carried on Undoubtedly an appreciable pressure would be developed to turn our people back to the rural districts and to tilling the soil for a livelihood. The tendency under the stimulus of manufacturing development has been the other way. The migration of late years has been toward, not from the cities Shall we perhaps find in the long run, in the increasing cost of iron and steel a partial solution of a much vexed problem? Will the cry "back to the soil" receive support in a way not generally anticipated? The question is an interesting one for speculation.

The general inference regarding copper is that the pinch of higher cost of production will be felt sooner than in the case of iron. We have no knowledge of such enduring reserves of copper ores as we have of iron On the other hand, copper, despite its vast importance, is not the fundamental necessity that is iron. It is used in less quantity in machinery and its increase in cost would less vitally affect manufacturing industries based on machinery. Advancing cost would cut it out of much ornamental work of inferior esthetic merit. The most serious effect would be found in raising the expenses of service in the applications of electricity. Electrical transportation, telegraphy and telephony would be more expensive than to-day. Unless wireless methods of transmission eliminate copper, or unless some discovery in the domain of physics which we do not now foresee furnishes a substitute for the omnipresent copper wire of to-day, we may find ourselves face to face with some curtailment in these modern aids to the easy conduct of life's affairs If in the course of several centuries the falling off in supply and the growth in population should raise copper to relatively high figures, we may wonder if a return in a way to the conditions of the middle ages will not result. Will copper then become to a greater degree than now the basis of skilled handiwork? Will the by-gone craftsmanship be revived and with a lessening total output shall we see an advance in artistic skill? In fact, if the vast development of machinery and the huge output of metallic objects at low cost—a condition so characteristic of to-day—should be checked or curtailed, would not hand-work on more valuable mediums of expression be restored It is not altogether unreasonable to anticipate fewer objects and higher crafts in their production.

The cases of lead and zinc are even more emphatic than that of copper. We have still fewer assured reserves and the pinch of increasing cost may manifest itself at an earlier date The two metals are not, however, quite such vital factors in modern life as is copper and the larger effects would be less apparent. Zinc is a necessary component in the manufacture of brass, which industry absorbs the greater part of the copper output A curtailment of either lead or zinc would cause inconvenience, but would scarcely occasion fundamental changes.

Silver will be very seriously affected by a decrease in the output of either copper or lead. Gold will feel these changes in an appreciable but far less degree. There will always be sufficient, however, of each of the precious metals for coinage, and beyond this use their applications, except perhaps in photography, concern luxuries rather

than fundamental necessities We can not attribute to them any profound possibilities in their influence upon civilization should the contributions of the mines decline In the recent past we have been more apprehensive regarding a too great supply of the precious metals, than regarding one too small

With the increasing interest in the discussions of the conservation of natural resources, there has been an increasing disposition of the authorities to assume supervisory powers over mining and metallurgical operations The old-time idea that to the crown, or, as we are accustomed to say, to the state, belongs the mineral wealth of the earth, is experiencing something of a revival The disposition to restrict the waste of valuable metals or minerals in processes of manufacture is commendable and after careful demonstration that it is feasible and just to the operating concerns, it may be wisely done The rejected product of concentrating mills or the "tailings" so called, when provided with appreciable percentages of metals, may well be stored where they can be utilized by future generations, if processes improve so as to make them available. That is to say, they should not be run into rivers, or placed where they will be dissipated. The same remark applies to slags from metallurgical works. The moderns, for example, are now working over the lead-bearing slags left by the ancients at the great lead mines of Laurium, Greece. Even the slags of early smelters in the west and Mexico may again pass through the furnace.

Another question relates to the discovery, location and ownership of mining property. So far as the metals are involved, and with the metals this address has been alone concerned, the valuable discoveries are so few in comparison with the disappointing attempts to develop, that only by encouragement and rather generous conditions will the prospector be enabled to follow his arduous calling. He must be offered large prizes proportionate to the many failures He must be assured of possession by a very circumspect and conscientious administration, if confidence in the justice of the government is to be maintained People in the parts of the country where mining for the metals is not carried on hear only of the great successes and little of the innumerable disappointments Far the largest part of the population thus acquire very distorted views of the real conditions of mining The interference by the government other than in the ways which I have mentioned and in maintaining reasonably safe conditions for the workman, is a matter to be regarded with great caution, lest irreparable injury be done to the large problem of maintaining our future supplies with such new discoveries and developments as may be feasible The wisest course is to improve the method of establishing and recording titles to new discoveries, and then, except in the matters already mentioned, to let the natural course of business assert itself The proper share of the state will be obtained through the normal processes of taxation.

The mines for the metals do not, however, present the most important phase of this subject Coal is a more serious problem, and one demanding more extended treatment than would be justifiable in an address primarily devoted to other themes. One may only express the hope that where cases of dispute arise they may be determined in the courts, according to the established rules of evidence.

The resources in the metals which have been found in the United States have proved so great as to make the industries based upon them a very vital factor in our

whole civilization Great changes in the supply or the cost will inevitably react in the long run upon the opportunities for employment and support, and upon the very nature of our national life While it will be a long time before rearrangements in the case of the most important of the metals, iron, will be manifest, and while they will assert themselves gradually, we are quite certain to face new conditions in copper, lead and zinc at an earlier date In the end, however, we can perhaps justifiably forecast a future in which agriculture will figure more and more prominently and in which the moral, intellectual and spiritual life of the nation will readjust itself accordingly Great and concentrated wealth is likely to be less in evidence, materialistic influences less pronounced, and from the vantage ground afforded by the greater comforts and opportunities of modern life as compared with that of a century or a half century past, we may in the distant future look forward to an evolution upon somewhat different lines Broadly viewed, the national life will probably be increasingly sympathetic with art and with ideals

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CITY SANITATION[1]

Great cities have grown and passed out of existence The enormous increase in urban population in very recent years has produced even greater cities, which may also in time cease to be In fact, aside from the possibility of local or cosmic calamity, this is sure to occur, unless due attention is given to the application of the principles of chemistry in our daily, personal and communal life London, Paris, Bombay, Rome and New Orleans have had their scourges in the past to testify to the fearful penalty of ignorance and neglect

Indications point to an urban growth and development, the conception of which taxes the imagination When we see New York as it was two hundred years ago, and then one hundred years ago, and as it is now, we may well wonder what it may be fifty years from now The annual increase in population is about 300,000. It has been calculated that in 1920 New York may have 7,000,000 of people

It has been predicted by a close and conservative student of sociology that two generations may see the eastern part of our country mainly composed of contiguous cities In 1790, 3 3 per cent of the population of the United States was urban It was 33 1 per cent in 1900 The problems of the state and county become closely interwoven with those of the city The city will no longer be merely an accumulation of human beings in a particular locality, with its local problems and influencing the state mainly in a financial way, but the city will have become the state

The individual needs fresh air, pure water, good food, safe shelter, and should have a clean body and something beautiful to look at When he associates himself into a city his needs are not lessened, but emphasized The growth of a city causes it to assume, willingly or no, corresponding obligations The inhabitants must breathe, they must be fed and watered, its wastes must be got rid of, facilities for the safe coming and going of its people at all times must be provided, as well as protection from fire or other adventitious circumstances which concern the welfare of the citizens The needs thus simply stated are to be met by obligations which become more and more complex with the increase in population In fact, most of the city's problems are of comparatively recent date

[1] An address at the tenth Conference of the Health Officers of the State of New York, Buffalo, N. Y, November 17, 1910

With your permission I shall address my remarks to certain specific matters which have come under my observation in Greater New York, and to which I have given special study. No doubt these matters have already been considered in some of your conferences, but the public expression of the independent point of view of one unhampered by official ties may serve one good purpose, namely, of provoking discussion, which can be made profitable.

The consideration of the air of cities involves not only the principles of ventilation, which will not be considered here, but the construction of the streets, means of transportation, the disposition of wastes, and the handling of the more unusual contaminants, which vary with conditions.

There are more than 2,000,000 miles of public roads in the United States outside of municipalities. These roads in many cases are essentially the same as we find in the outskirts of our larger cities, and are the roads of the smaller towns. The town roads are traveled very much more, so the actual facts at hand for the average road are applicable to the town roads, for which no satisfactory data are available. Cushman has calculated that 500,000 tons of dust are raised on the public roads per day, or, taking 100 dry days in the year, 50,000,000 tons of material are taken from places where it is needed and placed where it is undesirable by the movement of ordinary vehicles. A discussion of economic principles of road conservation is not germane to our subject. Suffice it to say that the modern motor-driven vehicle is not a dust maker, but a dust raiser.

The dust problem did not begin with the introduction of the automobile, although it has undoubtedly been accentuated by this mode of travel. There are sections of our country at the present time where the roads have been rendered practically dustless, and neither horse drawn vehicles nor automobiles can now deposit the dirt of the highways in the gardens and houses of abutting property owners. This condition of affairs did not exist before the introduction of the automobile, but has been arrived at in answer to the demand which has followed its use. In short, there are many suburban communities in which life to-day is far more agreeable, pleasurable and possible than it was before automobiles came into use.

Why may we not have this in every city?

Aside from the personal discomfort from flying particles of solid material, whatever be its nature, these particles are the bacterial aeroplanes. Sedgwick has shown that 10 liters of air taken five feet above a macadamized street in a dust storm may contain as many as 200,000 micro-organisms.

There is a natural fouling of the street surface and an unnatural fouling. The natural comes from excrement from animals,[2] detritus from wear of pavements, soot and dust from the air, leaves from the shade trees, and the grindings from tires and shoes. The unnatural, or, rather, avoidable causes are refuse thrown or swept upon the streets from buildings, refuse thrown by careless users and refuse spilled from vehicles carrying material through the streets. The latter causes are supposed to be prevented by the operation of ordinances which are honored in the breach, and these causes result in the greater cost of cleaning,[3] as the sweeper has considerable work in collecting litter before attacking the dirt, and the material is bulky.[4]

Commissioner Edwards, of New York City, says in *Municipal Chemistry* that

[2] One thousand horses will, in every working day of eight hours, deposit about 500 gallons of urine and 10 tons of dung upon the pavements. "On the Utilization of Stable Waste," see Birchmore, *Journal of the Society of Chemical Industry*, 1900, Vol. 19, p. 118.

[3] For cleaning all the boroughs in Greater New York of garbage, ashes, refuse and street sweepings, the Board of Estimate and Apportionment allowed an appropriation of $7,418,299.20 for 1909, and this amount was divided among the boroughs, Manhattan receiving $4,230,441.70, The Bronx, $560,371.30, Brooklyn, $2,492,481.20, and for general administration, $135,005.

[4] Very, "Municipal Chemistry," McGraw Hill Pub. Co., 1910, p. 243.

There are two general methods for disposing of street dirt, namely, it may be picked up, swept up, or shoveled up, and then hauled away, or it may be washed into sewers through the agency of water, or there may be a combination of these methods[5] As a rule, a considerable portion of the dirt is conducted away during rain storms, and some cities have especially constructed their sewers with the view of conducting off all dirt which can be reasonably emptied into them, in fact, it may be said that many municipal engineers consider that the sewerage system of a city should be constructed in such a way that it will carry off a large portion of the fine dirt from the streets

I will go further and say that the streets should either be made dustless or wet down with dilute chlorine water, that is, a solution of bleaching powder, or other disinfecting fluid Both methods have been used with success and are within reasonable cost

The topography of a district in which urban population has massed itself will, in a measure, regulate the mode of growth Although improved methods of rapid transportation have overcome the necessity of concentration, yet business and other causes continue to make for centralization, with consequent elevation in the value of land, whose acreage is increased only by vertical expansion The modern subway comes as a result. The air from the streets is sucked into these human mole holes It is to be hoped that the Public Service Commission will not allow the construction of any more subways, or that subways be built in other cities, except that the tracks be separated by partitions, or that the tracks of trains going in opposite directions will be kept in different compartments These have now been included in the specifications for the proposed subways in Greater New York For, although much street air enters the tunnels in New York at present, a large portion of the air is simply churned by the passing trains and not quickly and properly replaced. The ventilation in the London Tubes and in the Pennsylvania-Long Island Tunnels is excellent

There are many incidental impurities in city air that are local and more or less evanescent. I have shown that in the city of New York about 1,300 tons of sulphur dioxide are poured into the air daily in the combustion of coal. This is a sad annual economic waste of a most important chemical, some millions of dollars in value, which we do not know how to avoid or save at present

The smoke problem has confronted every city where coal is used as the main fuel. Civilized nations are only beginning to awaken their "conscience of fuel." Our methods of utilizing coal give us a return of only five per cent. of its energy when burned, and only one per cent when we convert that energy into electric light in the city.

Good firing is admittedly an important factor in smoke prevention, and it has even been regarded as the main factor of the problem,[6] but many authorities favor the distribution of gas as a means of at least alleviating the smoke nuisance.[7]

There have been many complaints against some of the railroads running out of New York City, because of the nuisance caused by their use of soft coal. Some of the suburban towns have taken legal action to prevent this. The solution of the smoke problem on the railroads reduces itself to the use of hard coal or oil, as the application of mechanical stokers and smoke-consuming devices to locomotive engines has

[5] Vacuum street cleaners have so far proved to be too expensive

[6] Caborne, *Jour. Roy San Inst.*, 27, p 142.

[7] For example, Lodge, Des Voeux, A. J. Martin and A. S E. Ackerman; in this connection, see *Jour Roy. San. Inst*, 27, pp 42, 64, 80, 85.

not proved to be a success, or better still in electrification.

The theory of Rayleigh[8] for dispelling fog, and with it smoke, by electrification is interesting and is demonstrable in a beautiful way on a laboratory scale, but the expense entailed and practical difficulties involved preclude its favorable consideration. However, this method is being used with more or less success in some of the smelters in the Pacific states.

One of the worst smoke nuisances about New York during the past few years has been caused by the garbage and other reduction plants at Barren Island[9] During this process of reduction, oil and grease are extracted from animal and vegetable matter, leaving a dry residue, which is used as a base for the manufacture of commercial fertilizers, the discarded residue being burned in the plant as fuel.

At another plant in this same point the carcasses of the larger dead animals, which are transported by a regular line of boats, are burned When the immense number of carcasses ordered removed annually by the New York Department of Health is taken into account, it is not surprising that the smoke given off with the accompanying odors should give offense to residents for miles around The number removed during the past year included 19,000 horses and about 380,000 dogs and cats, besides about 1,000,000 pounds of condemned meat, about 80,000 pounds of "too gamey" poultry, about 3,500,000 pounds of fish and about 5,000,000 pounds of offal.[10]

The necessity for a suitable supply of potable drinking water is now well recognized in every civilized community, and it is usually provided in the city, often at great expense, yet an appalling degree of ignorance is still encountered in the country districts that is difficult to overcome A large percentage of urban population does, and it is most desirable that every single individual in the city should, enjoy a few days or weeks in the country in the summer The ignorance of country habits is proverbial with the urban citizen, who takes certain matters for granted It is, therefore, not infrequent that these outings, picnics, etc., which should make for the better health, are the direct causes of unnecessary illnesses attributable directly to the drinking water, for all the liquid refreshments on these occasions are not limited to the national German beverage.

This is largely a matter of education Every teacher of chemistry has a splendid opportunity to drive these simple matters home, and I never fail to do it with the five or six hundred young men who sit under me every year But every citizen does not listen to lectures on sanitation, although frequent opportunities are given by the various lecture bureaus Popular bulletins, such as those splendid sheets which come so regularly from Dr Evans's office in Chicago, can do much good The press, when appealed to, will render great assistance

The public is inclined to believe that when an ample potable water-supply has been provided, all that is necessary has been done Sanitarians know that the contrary is the case. They may point out to the citizens that sewage disposal is quite as important. They may cite the story of Dantzic, which had good water in 1869, but the typhoid rate did not decrease materially until 1872, when sewers were added Vienna had good sewerage and bad water up to 1874; the death rate was 340 in 100,000 That year good water was supplied and the rate dropped to 11 in 100,000 With good water and no sewage the soil becomes saturated with refuse matter, a hot bed awaiting the planting of pathogenic bacterial seed Sedgwick, referring to cholera, figuratively states that "Pettenkoffer has given the key to the whole situation by saying that filth is like gunpowder,

[8] *Jour Roy. San Inst.*, 29, p 42; and *Elec Rev*, 47, p. 811

[9] Parsons, "Municipal Chemistry," McGraw-Hill Publishing Co., 1910, p. 333

[10] Parsons, *loc. cit.*

for which cholera is the spark. A community had better remove the gunpowder than try to beat off the spark, for in spite of their efforts, however frantic, this may at any time reach the powder, and if it does, is sure to blow them to pieces." The next great problem that New York City must solve will be that of sewage disposal. It will involve an expense vastly greater than the colossal sum now being spent for the magnificent new water supply.

Half the cost of living goes to pay for food. The centralization of population requires its transportation to the centers, but it does not enforce its exposure, uncovered in the streets or shops, where it collects the dirt and attracts flies. For a century it has been known that certain kinds of food could be preserved for later consumption without injury to health. There is no objection now to the preservation of food, provided it is done in the proper, that is, harmless manner. The adulteration and sophistication of food are outgrowths of the development of the city and the improved means for world-wide transportation, coupled with the degeneracy of those who live by bartering and their desire for luxuries. The chemist has been the Cartouche and Sherlock Holmes in the abominable business. Yet ignorance and disregard for the consequences so long as gain resulted have been behind the supply of one particular food, milk, which is the main support of the weak and helpless. The government has formulated satisfactory laws against the adulteration of the coin of the realm and enforces them vigorously. We have food laws now, but they are not satisfactory, nor are they always properly enforced. In fact, they can not be fully enforced as long as they admit of constant quibbling as to the meaning of common words in our language. No doubt these objections will be removed, for it is a time of fuller awakening to the conscience of our civic value.

Clothing which has been exposed to such infectious diseases as diphtheria and smallpox, is now destroyed or duly disinfected, at least theoretically. This is not the case with clothing, either second-hand or new clothing, made in the sweatshops, where we know tuberculosis is rampant. Clothing thus serves as a means for the spread of infectious diseases. This can be stopped by requiring new clothing to be thoroughly disinfected before allowing it on the market, or, better, by applying the old Mosaic law enjoining the strictest cleanliness. Moses really anticipated our modern sanitary laws, for cleanliness is the beginning and the end. The existence of sweatshops is one very dark blot upon the page of our vaunted civilization.

The problems of city sanitation no doubt can all be solved with unlimited means and unrestricted legal power and the machinery for exercising it. Practically, however, the economics involved affect the situation. Successful manufacturing enterprises usually begin with experimental plants and furthermore keep them constantly in operation afterwards as an economic means of improving their efficiency. Some cities have appreciated this principle as shown in the Lawrence Experiment Station at Boston. But these things cost money and all know what influence "taxes" are made to play in all political campaigns. It appears not unfrequently that the excuse is offered on the part of budget committees, or similar regulating bodies, for not apportioning appropriations, "we can not afford research." No political party could leave a more lasting monument, if it went out of existence, than the establishment of the principle that a great city can not afford not to establish experimental stations. If the leaks are stopped, there will be plenty left not

only to establish bureaus of investigation, but some to save as well

A progressive manufacturer does not hesitate long in substituting more efficient machinery He also knows that his people are more efficient and happier in good sanitary surroundings So, even if the leaks are stopped and the cost of running mounts up, the community is the better able to bear the burden and does it cheerfully The average American doesn't mind paying a suitable price for a satisfactory article, in fact, of late he has become somewhat accustomed to paying a little more than he should

The complications arising from the growth of cities call not only for "the employment of well-trained, tactful, honest, energetic and fearless health officials," but also lays a responsibility upon all forms of educational activity to bring about a "better appreciation by the people at large, of what is conducive and what a menace to public health," and individual safety

In regard to health officials, I can not refrain from expressing an opinion bearing upon the organization of a health department In the first place the head of the health department should be an expert sanitarian and not merely a doctor of medicine, whose training in sanitation has been incidental He should be a specialist in sanitation with the background of a medical doctor Furthermore, the numerous details, especially financial, should not be thrown upon the head any more than the captain of a warship should look after the details of the ship's larder The chief needs every particle of his well-trained brain and energy to deal with the great problems of the city's health He should be provided with a financial coadjutor—a man of absolute rectitude, and as well trained as himself, but along another line —a man who will see that the purchasing power of the city's money is equal to that of a private corporation The terms of office of these directors, technical and financial, should be limited to the period of normal human efficiency, decent pension provisions being made for them when that period shall have ended They would thus be unhampered by any political, religious or social associations, in the conduct of the department I recognize that such a proposition is somewhat radical—in fact in direct opposition to the opinion of some—and sounds a bit utopian, but I am glad to say that my confidence in my fellow man is such that I am willing to give such large powers to him Our democratic government breeds men worthy of such confidence, if it does not, then it is a failure, and we are not willing to acknowledge or to accept that verdict.

CHARLES BASKERVILLE
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SCIENTIFIC NOTES AND NEWS

AT the Minneapolis meeting of the American Association for the Advancement of Science, Dr Charles E Bessey, professor of botany and dean at the University of Nebraska, was elected president for the meeting to be held at Washington, beginning on December 27, 1911 It is planned to hold the meeting of 1912 at Cleveland. The meeting of the association and of the affiliated societies at Minneapolis was in every way successful. The registration of members of the association was 663, which represents an attendance of scientific men about twice as large. Owing to the distant place of meeting, it is necessary to wait until next week for the publication of the report of the general secretary and the addresses of the vice-presidents.

PROFESSOR ALEXANDER SMITH, University of Chicago, was elected president of the American Chemical Society at the Minneapolis meeting.

AT the meeting at Ithaca the following were elected as officers for 1911 of the American

Society of Naturalists: *President,* Professor H. S. Jennings, Johns Hopkins University; *Vice-president,* Dr. Geo H. Shull, Carnegie Institution, *Treasurer,* Professor E. M East, Bussey Institute, *Secretary,* Professor Chas. R Stockard, Cornell Medical School; *additional members of the Executive Committee,* Professor W L Tower, University of Chicago, and Dr B. M. Davis, Cambridge, Mass.

Professor W G. Farlow, of Harvard University, was elected president of the Botanical Society of America at the meeting held last week at Minneapolis.

Dr. W. H. Dall, of the U. S. National Museum, was elected president of the American Paleontological Society at its recent Pittsburgh meeting

The American Psychological Association at the Minneapolis meeting elected Professor C E. Seashore, State University of Iowa, as president, and Professor Walter V Bingham, Dartmouth College, as secretary.

Professor Frederick J. E. Woodbridge, professor of philosophy at Columbia University, has been elected president of the American Philosophical Association and Professor Walter T Marvin, of Rutgers College, vice-president

M Armand Gautier has been elected president of the Paris Academy of Sciences for 1911 M Lippmann becomes vice-president

Dr. Lewis Boss, director of the Dudley Observatory at Albany, and Dr Frederick Kustner, professor of astronomy at Bonn, have been elected corresponding members of the Berlin Academy of Sciences

Dr Richard Hertwig, professor of zoology in the University of Munich, has been made knight of the Maximilian order for art and science.

Professor J H Poynting, F R.S., has been elected a foreign fellow in the Reale Accademia dei Lincei.

Mr. Sydney Chapman, M.Sc., of the University of Manchester, has been appointed a chief assistant in the Royal Observatory, Greenwich.

M. Ernest Fourneau has been elected director of a newly-established laboratory for researches in the chemistry of therapeutics in the Pasteur Institute, Paris.

Dr. Karl Neumann, professor of mathematics in the University of Leipzig, has retired.

Dr John L. Todd, associate professor of parasitology at McGill University, will join the expedition sent by the Liverpool School of Medicine to Gambia, Africa, for the study of tropical diseases.

The movement set on foot by the Liverpool School of Tropical Medicine in commemoration of the work of Dr. J. E Dutton, who lost his life on the Congo through contracting spirillum fever while on the twelfth research expedition of the school in 1905, has now been completed The school has been able to offer Liverpool University £10,000 for the establishment of a chair in tropical entomology. At a meeting of the council of the university it was resolved gratefully to accept the offer.

At the New York Academy of Medicine meeting, December 15, the president, Dr. John A. Wyeth, gave a brief memorial address on the late Dr Robert Koch, honorary fellow of the academy. Dr. S. Adolphus Knopf, who was a student under Dr. Koch, presented a portrait of Dr. Koch.

Dr. Willis G. MacDonald, professor of surgery in Albany Medical College, died on December 30 at the age of forty-seven years.

Dr. Franz Konig, formerly professor of surgery in Gottingen and Berlin and later head of the surgical Hospital of the Charité, Berlin, known for his work in the treatment of articular tuberculosis, died on December 12, at the age of seventy-eight years.

The death is announced of Dr. A. Kraemer, formerly professor of agriculture in the Zurich Polytechnic Institute, at the age of seventy-eight years

The Elizabeth Thompson Science Fund was established by Mrs. Elizabeth Thompson, of Stamford, Conn., "for the advancement and prosecution of scientific research in its broadest sense." The income from this

fund is now available, and the trustees desire to receive applications for appropriations in aid of scientific work. The trustees are disinclined, for the present, to make any grant to meet ordinary expenses of living or to purchase instruments, such as are found commonly in laboratories. Decided preference will be given to applications for small amounts, and grants exceeding $300 will be made only under very exceptional circumstances. Applications for assistance from this fund, in order to receive consideration, *must be accompanied by full information*, especially in regard to the following points (1) Precise amount required. Applicants are reminded that one dollar is approximately equivalent to four English shillings, four German Marks, five French francs, or five Italian lire (2) Exact nature of the investigation proposed. (3) Conditions under which the research is to be prosecuted (4) Manner in which the appropriation asked for is to be expended. All applications should reach, before February 1, 1911, the secretary of the board of trustees, Dr C. S. Minot, Harvard Medical School, Boston, Mass, U. S A.

IT is stated in *Nature* that a prize of 100,000 francs is to be awarded to the inventor of a practical apparatus which will make it possible to save the crews of wrecked submarines, enabling them to regain the surface uninjured The French minister of marine is able to offer the prize, as he has received an anonymous gift from a French lady for the purpose.

MR. THOMAS LUPTON, of Great Britain, solicitor to the Royal Institution, who died on October 30 last, aged 90 years, left £10,000 for the general purposes of that institution.

THE department of zoology and entomology of the Ohio State University has recently received the gift of a fine collection of Lepidoptera from Mrs. Catherine Tallant, of Richmond, Indiana. The collection was made by Mr W. N. Tallant and contains mainly species occurring in central Ohio, especially at Columbus, but has also a number of species from different parts of the United States, and also some fine samples of species occurring in South America, Japan, China, India, Ceylon and Africa. The collection contains about 10,000 specimens in most excellent condition, very beautifully mounted, and many of the species contain very full series, showing variations, etc, which will make them of special value for scientific study They are, for the most part, carefully identified and will be kept under the name of the "Tallant Collection" Taken with the other collections in Lepidoptera, the collection of Odonata left by Professor Kellicott, and those in various groups which have been accumulated by the efforts of the members of the department, the university is now provided with excellent series of insects, including representatives in all the different orders The total number of specimens in all orders probably approaches close to 100,000.

THE expedition sent by the Carnegie Institution of Washington for geologic exploration in China in 1903–04, in charge of Dr. Bailey Willis, secured a number of large negatives of Chinese scenes representing the scenery; the geological conditions, particularly of loess landscapes, and also of Chinese buildings, monuments and people. The route of the expedition through the provinces of Chili, Shansi and Shensi, led through the loess district and some remote mountain regions of great interest and scenic beauty. This collection of photographs has been placed on file with the Smithsonian Institution and copies may be had for educational purposes by application to the secretary of the institution and payment of costs.

TRINITY COLLEGE, Hartford, Conn., has retained the Ralph B. Carter Company, of 50 Church Street, New York, to install a circulation sea-water system in the five marine tanks in Boardman Hall, similar to the one which they placed in the aquaria house at Princeton. Hard rubber piping and valves are used to convey the sea-water from cedarwood tanks, and return the water to the reservoir, also of cedar, by way of a sand filter. The water will pass through a bronze motor-driven compressor

into an air reservoir where aeration will take place and air and water together will be pumped through the pipes to the aquaria, thus differing from the Princeton system where a column of air is forced against the water in the pipes and the water does not enter the pump The tanks may be converted immediately into fresh-water tanks, whenever this is desired.

THE subjects and dates of the lectures to be delivered before Easter at the Friday evening meetings of the Royal Institution of Great Britain are as follows January 20, Sir J Dewar, "Chemical Change at Low Temperatures", January 27, Professor W H Bragg, "Radioactivity as a Kinetic Theory of a Fourth State of Matter", February 3, Mr A E Shipley, "Grouse Disease"; February 10, Mr S Colvin, "Stevenson"; February 17, Professor H E Armstrong, "Digestive Activity", February 24, Professor Jean Perrin, "Mouvement Brownien et Realité Moleculaire" (in French), March 3, Professor Karl Pearson, "The Inadequacy of Causation in Modern Science", March 17, Mr J H Balfour-Browne, K C, "Water Supply", March 24, Sir D Gill, "The Sidereal Universe", March 31, Professor H S Hele-Shaw, "Traveling at High Speeds on the Surface of the Earth and Above It", April 7, Sir J J Thomson, "A New Method of Chemical Analysis" A course of Christmas lectures on "Sound Musical and Non-musical" will be given by Professor Silvanus P. Thompson in the afternoons of December 29 and 31 and January 3, 5, 7 and 10

UNIVERSITY AND EDUCATIONAL NEWS

COMMEMORATIVE exercises in celebration of the completion of the first twenty-five years of the work of the Carnegie Laboratory of New York University, and of the opening of the Carnegie laboratory extension, will be held on the afternoon of January 10. Addresses will be made by Mr Andrew Carnegie, Dr. William H Welch, Dr Henry S. Pritchett, Dr Hermann M. Biggs and Mr Jerome D Greene.

THE fifth congress of the American School Hygiene Association will be held at the Academy of Medicine in New York City on the second, third and fourth of February A tentative program includes papers by Lyman A. Best, William H Allen, Dr. S W. Newmayer, Dr Myles Standish, Dr. Woods Hutchinson, Dr Thomas F. Harrington, Dr W. S. Cornell, W E Watt, Dr Arthur T Cabot, Dr Luther H Gulick, Leonard P. Ayres, Dr Helen MacMurchy, Professor William H Burnham and Dr John J Croner.

DURING the thanksgiving recess at the University of Illinois, a party of electrical engineering students and of architectural students took a trip of inspection to various points in the vicinity which are of especial interest to engineers The electrical students visited the Quarry Street power station, the steel works at Gary and the works of the Allis-Chalmers Company at Milwaukee. The architectural students visited various buildings in Chicago and inspected the plant of the Northwestern Terra Cotta and Tile Company

Professor C. S. Sherrington, F.R.S., of Liverpool, and Dr. William Bulloch, director of the Bacteriological Laboratory of the London Hospital Medical School, were appointed members of the advisory board of the Beit Memorial Fellowships for Medical Research The next election of fellows will be held in December, 1911 The last date for receiving applications from the colonies and abroad is October 1, 1911, from Great Britain and Ireland November 1, 1911. Communications should be addressed to the Hon. Secretary, Beit Memorial Fellowships for Medical Research, 35, Clarges Street, London, W.

IN behalf of a donor who withholds his name, Mr George L Rives, chairman of the trustees of Columbia University, and Mr Robert W. DeForest, president of the board of managers of the Presbyterian Hospital, announce that $1,300,000 has been pledged for the perfection of an affiliation between the hospital and the College of Physicians and Surgeons of the University The gift comes through Mr. Edward S. Harkness, of New York and Cleveland, who gives $300,000 for a surgical pavilion and a laboratory for research work. Several conditions are named, the two

most important being: (1) That the hospital shall admit to the wards students of the medical schools to the extent and in the manner permitted by the most approved practise. (2) That the educational institution concerned may make nominations to all positions on the hospital staff, medical, surgical and special.

THE completion of the fund of $750,000 for the Johns Hopkins University is announced. This insures the payment to the fund of a further $250,000 offered conditionally in February of last year by the General Education Board.

BY the will of Mrs. Martin Kellogg, Yale University receives a bequest of $50,000 from the estate of the late Martin Kellogg, who was formerly president of the University of California.

MR. H. J. PRIESTLEY, M.A., assistant lecturer in mathematics at the University of Manchester, has been appointed professor of mathematics and physics in the newly-constituted University of Queensland.

DISCUSSION AND CORRESPONDENCE

SYMBOLS IN ZOOLOGICAL NOMENCLATURE

PROFESSOR NEEDHAM'S proposal[1] of a plan for practical nomenclature deserves more attention than has yet been given it publicly. To be sure, our energetic friend Professor Cockerell has published a brief destructive critique[2] based on personal opinion as to what can be most easily retained by the memory, and on sentiment. As to the former, one might differ from him in individual cases, or might justly observe that memory is not the only factor involved in Professor Needham's proposal. So far as sentiment goes the incongruity and falsity of many names will make as good an argument on the other side of the question, while the colorless number adapts itself far better to changing interpretations with the progress of science than any word with its fixed relation to ideas. Nor can I believe that it is any part of scientific nomenclature to "call up pleasanter [philological] thoughts." It certainly is worth while to have the great names of the past brought to our attention, but such men are in our thoughts constantly not because they have named a few species more or less, but because they have made real contributions to the progress of science. And what shall one say of the constant burdensome recurrence in systematic work of the names of the unknown, of those who have torn down the good work of their associates and have left the roadway of science rocky with synonyms, errors in determination and description, false statements and careless records, misspellings and misquotations. It is these rocks in the way that make the pilgrim to-day toil wearily up the height more conscious of the obstacles such men have left than of the substantial roadway the real workers have constructed.

But to my mind all of this fails to reach the heart of the problem or in any way to affect the fundamental contentions urged by Professor Needham. For this reason I am anxious to aid if possible in directing attention to the real questions at issue and the probable lines for their successful solution.

The history of all science shows intercurrent tendencies towards simplification and complication. The data already established are reduced to greater simplicity in expression and the new relations that are demonstrated involve them at the same time in constantly increasing complexity. That simplification in terminology is a real tendency is apparent to every one who studies the history of zoology and compares the long and involved circumlocutions of early writers with the more precise designations of to-day. Hand in hand with this simplification in form goes a movement towards standardization in use and meaning which finds its expression in modern terminology. The term becomes more precise as it becomes more limited and because its use is limited.

The history of zoology does not in this respect differ from the past of other sciences and yet the comparison shows that some other sciences have progressed further along this

[1] SCIENCE, September 2, 1910, pp. 295–300.

[2] SCIENCE, September 30, 1910, p. 428.

line of development than zoology has yet gone. Such a simplification by the employment of symbols has become thoroughly incorporated into the substance of some sciences and is proposed for introduction into others An examination of these conditions shows some interesting and in my opinion valuable considerations for this discussion

Probably because numbers were the basis of mathematics the origin of the science is often said to date from the invention of numbers. But even with that it may be noted that the symbols were not in all cases identical and in one system Roman letters were employed, whereas another used Arabic numerals for the same general purpose Nor can one well doubt the superiority of the Arabic notation over the Roman even if sentimental grounds lead one to prefer the classical to the Moorish civilization in laws, government or other social conditions Probably mathematics represents the most highly developed of all sciences and the modern mathematician is not deterred from the use of symbols by any danger of misprinting, confusion, error of memory or other similar objection, real though each of them is in this case also.

The case of chemistry is even more enlightening because the introduction and universal use of symbols is of comparatively recent date. One does not have to seek far to find arguments against the use of symbols for the designation of chemical elements which read strikingly like the objections of Professor Cockerell to the plan which Professor Needham advocates Errors do occur in chemical literature, proofreading is far more difficult because of the numerous easily confused symbols in use to-day and the abandonment of those quaint old names which disclose some of the secrets of the alchemist and of the mystic age of chemistry, was a real sentimental loss Yet I doubt if any one could now be found who would seriously contend that we should return to the presymbolic days even if it were possible to express modern chemical work in ancient form. Simplification through the use of symbols has come to stay in chemistry as in mathematics.

It is no argument whatever against the general proposal to introduce some such system into biological sciences to say that the latter are less precise, that their units are more numerous and more complicated than those of mathematics or chemistry. If the problem had been as simple it would have been solved as easily as were the others The delay in reaching any solution indicates the existence of difficulties but does not afford any basis for rejecting efforts to solve the problem or for characterizing the problem as insoluble along this line The greater complications of biology make its development slower because they demand for their consideration and analysis a more highly organized general scientific foundation and a more highly trained body of scientific workers The solution may not come in our time, but it will surely come some day.

But other sciences also are looking for possibilities of simplifying and of standardizing their forms of expression in the manner so successfully adopted by chemistry. One example of most recent date may suffice to show the tendency. This is taken from what may be regarded as the most recent addition to the circle of sciences, geography. In an address before the Geographical Section of the British Association at Sheffield this year, the brilliant young Oxford geographer, A. J. Herbertson,[3] dwells upon this matter, saying in introduction, "I have long thought that we shall be driven to some notation analogous to that of the chemists." After suggesting a possible scheme for consideration he adds: "This is the roughest suggestion, but it shows how we could . . . No doubt there would be many discussions . . . But after all these discussions would be more profitable than quarrels as to which descriptive term, or place name or local usage should be adopted to distinguish it."

With only minor changes in phraseology this description of dangers and profitless discussions which geography should avoid portrays actual conditions in the zoological field.

[3] SCIENCE, November 25, 1910, p. 745.

Zoological nomenclature has received heroic treatment during the past ten or fifteen years The difficulties which had arisen in the natural course of development under the Linnæan system had led to numerous isolated efforts for their correction until finally an attempt has been made to remedy the evils under the control of a central organization which has been so firmly established by zoologists as to be at present beyond their control and swayed by laws alone. Yet even such an autocratic and omnipotent body has not succeeded in doing more than increasing the difficulties of the situation It really seems as if the problem requires more radical measures for its solution The present plan of organization is incapable of coping with the complications which have arisen in the rapid expansion of biological knowledge during the last half century. Personally, I am convinced that the Linnæan system offers no probability of meeting the situation. Of this there may be some question, but there is abundant evidence to show that the existing zoological nomenclature is meeting with wide-spread criticism and does not command the support to be expected of so fundamental a system. Indirect but weighty evidence of this may be found in the fact that the use of common names is increasing and that a larger proportion of biological workers than ever before are avowedly indifferent to the use of technically correct scientific names.

Present conditions are denominated unsatisfactory by able men in many places and in diverse special lines of work in the general field. The most important general criticisms of the existing conditions may be stated briefly as follows:

1. *Lack of Stability*.—Present nomenclature by law depends upon the accuracy of the past and upon the completeness of our knowledge concerning its work. At any time demonstration of an error in statement or of an omission in the references to previous work may overturn a name or series of names and throw all the literature on the group into confusion. New laws and new rulings are made with the same result, for in our effort to out-Herod Herod we go further than the law, that most conservative of professions, has ever gone We make and enforce *ex post facto* laws which upset the established practise of a century.

2 *Overemphasis upon Trivial Features*.—Page-long discussions recur constantly on the acceptance of *A*'s name or *B*'s name and both sides argue with apparent justice and at interminable length Articles follow hard on each other's heels dealing exclusively with the spelling of names: Shall it be *somum* or *somai*? Shall one write *nni* or *nii*? And the questions are never decided, for even the high priests of the movement differ in their views and their practises, and the great majority of biological workers pay little attention to the strife because they feel the issues are trivial. Now the real meat of the question is the thing and not its name And all this energy devoted to a study of the animal itself would yield much of value to science. The workman does not care whether *A* or *B* gives him his tools, he wants a tool and wants it sharp, because he wants to do work with it. He is rightly impatient of so much hair splitting to so little purpose, but he does look forward to the time when in some way this energy may be diverted into productive channels.

3. *Exaltation of Error*.—If a tyro commits an error, if a neophyte goes astray or makes a foolish move, we are accustomed in science otherwise to consign his work to kindly oblivion, but in nomenclature this may not be. The skeleton of his misbirth must be hung in the public hall of the systematic museum, to dangle its misshapen bones before both students and visitors for all time. There is no other option possible to-day under the laws of nomenclature. A mistake once incorporated in the literature of biology must forever remain there, even though apparent to the man of education at a glance The most conservative theologian would hesitate to support such an inflexible demand for the maintenance of the past, errors and all. And the very fact that able and zealous advocates of present nomenclature contend there is no other way under the present system compels

the conclusion that this system is insufficient for the needs of a science which seeks to eliminate error and to establish truth.

4 *Multiplication of Complications*—No one can doubt that the complexity of zoological nomenclature has increased enormously within very recent years Furthermore, no one will deny that much of this increase is due to the expansion in our knowledge of the biological world and its interrelations This natural growth in complexity is as welcome as it is inevitable, but if real progress is to be achieved it must be accompanied by a perfection and simplification of the machinery of control and of investigation in which a prominent element is the systematic nomenclature of the subject Now there is reason to believe that the system in use has become unnecessarily intricate, that its parts are involved by the nature of the case in ways such as to create grave difficulties for the ordinary worker These difficulties are certainly greater to-day than they were twenty years ago and this result has been produced by the changes and complications incident to the new legislation in the subject during very recent years Such changes may have been wise and necessary from the legal standpoint, they may be perfectly in line with the natural development of the present system But that only strengthens my contention that zoology must look for a better system, must seek a way of escape along an entirely new line. I am aware also that these changes meet the approval of those who have devoted much time to the study of taxonomy and that they do not regard the complications as hindrances to progress No doubt from their point of view this is true, but there is another aspect of the question which deserves careful examination

To the skilled systematist, thoroughly acquainted with his own groups, confident, accurate, critical, these difficulties constitute intellectual stimuli rather than stumbling blocks He follows the changes in names with delight in the history of the science that they portray. Outside his own corner of the field he often does not care to go, or if he wanders it is not so far afield that he is at a loss to find the necessary help to keep him in the path But to the general worker this constant shifting constitutes a real burden that retards his progress and reduces the efficiency of his work. This is, however, not the most serious feature of the case

To the general public even in the educated world scientific names will perhaps remain as they unfortunately now are regarded, "beyond the powers of ordinary mortals," and birds and beasts, insects and shells, will continue to be called by their popular names because the latter are not only simpler, but also do not change from day to day But to the neophyte who hesitates on the threshold of the science, uncertain whether he shall enter or who later pauses before he essays to mount to higher levels in the fields of our elysium, the difficulties which our present nomenclature sets in his path are at best disheartening He would read of the great work of the past and know its relation with that of the present But you must tell him that *Amphioxus* is not such but *Branchiostoma,* that *Holothuria* is not an echinoderm, that even *Amœba* to-day is *Chaos!*—and a multitude more changes which confuse his mind and dull his enthusiasm He wants to study life, not letters But at the very start of his work he is forced to violate that canon of accuracy which is the foundation of science or to assume a burden that wastes his energy in a vain effort to keep up with the latest revisions of nomenclature. Like Sindbad the Sailor, he struggles along with this Old Man of the Sea on his back until he decides to be quit of his burden, and without openly indicating his purpose, contrives to wander off with the morphologists or biologists, leaving nomenclature behind.

Now these multifarious complications are the necessary and logical consequences of the system of laws which zoologists themselves have adopted and as such are unavoidable in the opinion of the expert legalist. The natural reply to such a dictum is then let us follow the promptings of our scientific consciences and devise some better system. Why should we not find a simpler and effective

method of designation in a system of symbols such as other sciences have found? I am not in sympathy with those who look for relief in a laxer more open administration of the present system. Such a line of action does not seem to me likely to prove either effective or legitimate.

This rigor in systematic nomenclature is a natural reaction from the free and easy methods which have prevailed in the past. Biological science even to-day publishes loose, inaccurate statements in research contributions which would be laughed out of court in physics or chemistry, to say nothing of mathematics or astronomy. It is necessary that some reform be undertaken, that our branch of science approach more closely to the precision in observation and experiment, in record and discussion that characterizes older sciences. The natural lack of fixity in biological phenomena has been utilized to excuse a lack of precision in method and investigation which must be corrected. One effort to reach a more justifiable basis is seen in the recent development of statistical work, and in the publication of definite numerical results rather than merely generalizations in connection with experimental work, in the effort to control more accurately and state more precisely the conditions of such experimentation and to analyze more closely the results obtained. In such lines zoology has achieved wonderful progress in the last twenty years or even less.

The same influences will lead to a reform of our system and, following the lead of other sciences, such a reform is likely to be accompanied by the simplification which is associated with the utilization of symbols. The far-seeing biologist should be on the watch for a plan which promises some measure of success in this line, he should welcome all reasonable attempts at the solution of the problem. Of course he will not reject any and all systems because they are new departures, and yet he should not fail to subject each to careful consideration because it may seem to be inadequate or only partially worked out. Out of such careful discussion will come the longed-for result in a workable form. But the system itself will represent contributions from many sources.

I confess that Professor Needham's plan seems to me at most only a partial solution of the problem. Even as such it may prove to be of great value and it is to be hoped that biological workers may be willing to try it on various groups in diverse portions of the field and may then report on their results. Better still if it could be subjected to a trial by some recognized society or institution with a view to testing thoroughly its character. It would be valuable to compare it carefully with the much more complex system proposed some years ago by Tornier[4] which seems to have attracted no attention, although it was a most ingenious and original means of formulating a symbolism for zoological nomenclature. While this system was much more complex and covered not only species as proposed by Professor Needham's plan, but also genera, and indicated the precise place in class, order and family occupied by each genus and species, yet apparently the symbol used for a given form would not be permanent and independent of changing views regarding the position and relationship of genera and higher groups. This lack of stability would be a serious, if not fatal, objection to the introduction of a new system planned to correct precisely the same defect in the old.

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BOTANICAL EVIDENCE OF COASTAL SUBSIDENCE

IN a recent article[1] Professor D. W. Johnson calls attention to certain conditions at Scituate, Mass., which are there responsible for a fictitious appearance of coastal subsidence. During the "Portland Storm" of 1898 the bar was broken which at that locality almost separates the North River marshes and bay from the ocean, with the result that the high tide level on the marshes is now from one to several feet higher than it was then.

[4] *Zool. Anz.*, Vol. 21, p. 575, October 24, 1898.

[1] SCIENCE, N. S., XXXII., 1910, p. 721.

Trees surrounding the marsh have been killed and are now standing among salt marsh grasses. Since breaches in bars, widening of tidal inlets and other shore-line changes may cause local fluctuations of a number of feet in the high-tide surface, Professor Johnson hastily concludes that no evidence of recent subsidence on the New England coast thus far presented can be considered satisfactory.

It is the mean sea level, rather than the irregular and changeable high-tide surface, which is most important in discussions of coastal subsidence. Below mean sea level the salt-marsh builders, *Spartina glabra* and *Spartina patens*, can not live. As a matter of fact *Spartina patens*, by far the more important of the two plants, seems to occur in significant amount only within a vertical range of about two feet. It builds its turf up to mean high-tide level. Above this level it is for the most part replaced by other plants, notably by *Juncus Gerardi* and various species of *Scirpus*. We may, therefore, regard any thickness of *Spartina patens* turf greater than two feet as a measure of change in high-tide level. If such turf extends to mean sea level, or below it, the evidence that subsidence has taken place is indubitable. If a deep turf is of uniform texture throughout, a strong presumption is created that subsidence has continued uniformly to the present time. *Spartina patens* turf lies below mean sea level at many places in the vicinity of Boston, as, for example, near the mouth of the Saugus River, where it forms a homogeneous stratum to a depth more than ten feet below high-tide level. The geological significance of turf formation by *Spartina patens* has been pointed out by Professor C. A. Davis,[2] of the Bureau of Mines. He presents substantial evidence that coastal subsidence is now going on—evidence to which the hypothesis of a fluctuating high-tide level has no possible application.

Aside from the value of the salt marsh deposits themselves as indicating subsidence, there is still another type of botanical evidence which Professor Johnson should not so lightly have disregarded. In certain cases where fresh water peat is found below mean sea level, in obviously undisturbed relationship to the substratum, whether or not the deposits have ever been invaded by the sea, we have incontrovertible evidence of subsidence. The full argument in support of this statement has been published elsewhere,[3] but may be briefly reviewed here.

Peat deposits are of two main types, depending upon the relation of the water table to the ground surface in the depression in which they are formed. In the first type the depression contains a pond or other body of water, so that the peat is derived from aquatic plants and from the surface of the water, through the agency of mat-forming plants. If the water in such a depression were fresh, a mat might be formed at or slightly above sea level, and fresh-water peat of this type would then be laid down below sea level. If the ocean should break into such a bog it is conceivable that the mat might settle considerably and then be covered by salt-marsh deposits. Such a condition I have never seen.

The second type of peat deposit is built up from the ground by successive elevations of the water table, as we know from the character of the plant remains which it contains. At every stage of growth its surface has very nearly coincided with the ground water level. Since in coastal Massachusetts the water table is never lower than sea level, a bog of this type, if its bottom is lower than mean sea level, must of necessity be interpreted as a record of subsidence.

There is a locality at Quamquisset Harbor, on the coast of Buzzard's Bay, where the sea has cut into a *Chamaecyparis* bog. At the water's edge a sounding showed uniform peat, containing *Chamaecyparis* wood, to a depth of fourteen feet below mean sea level. The sand bottom of the deposit had not been disturbed by under-cutting. At the point where this sounding was made, there were salt-marsh deposits in a thin layer overlying the peat,

[2] "Salt Marsh Formation near Boston and its Geological Significance," *Economic Geology*, V, 1910, p. 623.

[3] "The Submarine Chamaecyparis Bog at Woods Hole, Mass.," *Rhodora*, XI., 1909, p. 221.

but further inland the *Chamaecyparis-Sphagnum* peat was still forming, at an elevation perhaps three feet above high-tide level, and soundings showed that the deposit was uniform from top to bottom. Within a very few feet of the seaward edge of the marsh there are still two or three small stumps which project several inches above the *Spartina patens* turf which has grown up around them. These constitute a strong argument that subsidence is still going on. If there had been no subsidence for 3,000 years, as Professor Johnson thinks likely,[4] these little stumps would surely have rotted away by this time!

The Coast and Geodetic Survey has furnished data regarding the tides in Quamquisset Harbor. Spring high water is 2.4 feet above mean sea level. Mean high water is 2.0 feet above mean sea level. The highest tides observed were 3.0 feet above mean sea level. These tides at Quamquisset are so low that Professor Johnson's hypothesis of a fluctuating high-tide level can not possibly be invoked in explanation of the submarine peat beds.

After examining one locality where salt-marsh plants have invaded a fresh-water vegetation under conditions certainly far from typical, and where all of the fresh-water remains are found at extreme high tide, Professor Johnson has ventured to characterize all the evidence which has been offered for recent subsidence as inconclusive. As a matter of fact his hypothesis has no bearing whatever on most of the evidence which has been offered.

H. H. BARTLETT

BETHESDA, MD.

FACULTY OR PRESIDENT?

THE discussion of the merits of control by the faculty or by the president in any educational institution, which has been presented from time to time in SCIENCE, was continued by some references in Professor Cattell's article in the issue for November 11, and by a short paragraph in the abstract of President Schurman's annual report in the following number. There is still another angle from which the matter may be viewed.

The student body in a college, or university, is a comparatively constant quantity. The great majority of students spend the four years from about eighteen to twenty-two in the institution of their choice. The average age of the student body, taken as a whole, would, therefore, be slightly under twenty, owing to the somewhat greater numbers in the freshman and sophomore classes. Whatever fluctuations there might be from year to year, in consequence of an exceptionally large or surprisingly small entering class, or because an unusually large number from the upper classes turned to professional work before graduation, they would be within very narrow limits, so narrow, indeed, that the entire body of students might be regarded as an individual not quite twenty or just over twenty years of age. The same would be true of a university with the various professional schools and the liberal arts or undergraduate department, although the average would probably be three or four years higher. The student body itself, none the less, would be comparatively stable.

If we turn our attention to the faculty, we find another fairly constant quantity. Since the retiring age is somewhere about sixty-five or seventy—it might be a little over or a little under—and since the youngest instructors are just out of college, the average age of a faculty would be somewhere between forty and forty-five, as a rough estimate. If there should be an unusually large number of young instructors, or an extra large number of elderly professors, then the average age would be lowered or raised correspondingly, but in either case it would not be far from the age mentioned above, and from year to year the fluctuations would be within rather narrow limits, so that there would be a fairly stable body to exercise control of whatever sort. In those institutions in which the youngest instructors have practically no voice in the administration, the average age would be raised, but the faculty would retain its characteristic of a constant quantity.

When the problem is presented in this way,

[4] SCIENCE, N. S., XXXII., 1910, p. 709.

we have two constants sustaining a constant relation to each other. They are not so far apart, too, in the matter of age, but that each may understand the other. The relation is essentially that of parent and child. The student body may be regarded as of a healthily radical temper of mind, and the faculty as healthily conservative Sociologists maintain that both radicals and conservatives need to be united in a community, with the center of gravity slightly on the radical side, if that community is to be healthily progressive With the faculty and students viewed as above, the conditions are right for a sanely progressive institution, since we may, perhaps, assume that the larger size of the student body would give the desired overplus of radicalness At any rate, there would be a steadiness of control and of purpose, and a sufficiency of sympathy to insure hearty cooperation and splendid scholarly results.

When, however, we consider the matter from the side of the one-man power, whether that man be president, or some other official with the bit in his teeth, the conditions do not seem to be so favorable for desirable results If the president be young—we will say thirty years of age, as sometimes happens—the center of gravity is too much upon the radical side, when the same man gets to be sixty-five or seventy, provided he stays that long, or has an elderly successor, the balance shifts too much in the other direction It is true, of course, that there are conservative young men and progressive old men, but, none the less, the fluctuations in the age of the controlling official constitute a variable more likely than not to be a disturbing factor in the otherwise constant and harmonious relation between faculty and students In the case of the elderly man being in supreme control, the relation of parent to child will be superseded by that of grandparent to grandchild, with consequent ready indulgence or excessive rigor The latter is, perhaps, the more likely, since the nervous strain develops irritability and the exercise of power breeds arbitrariness.

When the problem is viewed from this angle, the wise policy would seem to be to have faculty control in an educational institution, rather than that any one man should reign supreme.

GREGORY D. WALCOTT
HAMLINE UNIVERSITY,
ST PAUL, MINN

THE MATTER OF UNIVERSITY FELLOWSHIPS

TO THE EDITOR OF SCIENCE The address of Dr Jordan as retiring president of the American Association for the Advancement of Science, printed in your issue for December 30, contains many things that will appeal to every one as both true and timely, there is the more reason to regret that some things are said against which, I think, protest should be made I do not believe it is true, as he seems to think, that the system of university fellowships is a powerful influence working against our best university ideals Dr Jordan seems to me to have lost sight of some very important facts when he stigmatizes the fellowship system as one "whereby men are hired to work under men they do not care for and along lines which lead not to the truth they love, but to a degree and a career." I am sure he does injustice when he asserts that "The embryo professor asks for his training not the man of genius who will make him over after his kind, but the university which will pay his expenses while he goes on to qualify for an instructor's position"

All will admit that the fellowship system has not always been wisely administered, that evils have crept into the practise of some institutions, that these ought to be (I think can be) corrected We have all had experience of the man whose letter expresses a desire to work at our particular university and inquires, "What inducements can you offer me to come?" Undeniably, universities are themselves responsible in some measure for making possible such an attitude; but it would seem that only a particularly unlucky experience could make one regard this as typical of the graduate student in general

Dr Jordan's ideal university is one where advanced students are "gathered around a man they love, and from whose methods and

enthusiasm the young men go away to be like centers of enthusiasm for others" It is a high and noble ideal, and one towards which we are all most heartily ready to strive; but it is rather difficult to follow the logic of the conclusion that a fellowship system tends to destroy this ideal It would be invidious to refer to particular men or universities had not Dr. Jordan himself set the example by naming, among others, four eminent teachers at one university who exemplify the ideal he has in mind It is entirely true that these men drew students about them by the force of their ability and personality, but is it not also true that the university which placed them on its faculty did more than any other American university had previously done, by a system of wisely administered fellowships, to make such a gathering of students possible? It was my own good fortune to be one of those students, and I count it not only as a lasting honor but as the most important turning point in my life that appointment to a university fellowship enabled me to place myself under the inspiring influence of three of the four men whom Dr Jordan names I am sure that many others whose after lives have been given to teaching and research can bear like witness

Dr. Jordan argues that it would be a difficult task to produce a Darwin, given the raw material, "if a fellowship of $500 had drawn him to a laboratory of some lesser plodder" But what does this prove if not the desirability of trying to widen the usefulness of the gifted teacher by making it easier to gather students of promise about him, and by helping such students as well as we can to the opportunity they seek? Happily for science, the circumstances of the youthful Darwin placed him beyond the need of such aid He was free to "walk with Henslow" (to quote Dr Jordan's own happy phrase), but had it been otherwise, who can estimate the value to the world of a helping hand to Darwin at a critical moment? We are sometimes told that fellowships tend to "pauperize" students. I do not believe it. All honor to the man who works his own way through college and university life. But the years of graduate study, perhaps above all others, ought to be a time of undisturbed and unremitting devotion to one's chosen work The man whose ability and scholarship have proved him worthy to enjoy the privilege of at least one such year is in no danger of pauperization by the fellowship that gives him the opportunity If he has been well chosen, his stipend is as well earned as that of any officer of the university. In my belief the university makes no better investment than the $500 a year that enables the man of talent, but of limited means, to carry on his work, and the example and influence of such men among the body of graduate students constitute one of the best assets of the university

EDMUND B WILSON

COLUMBIA UNIVERSITY,
January 1, 1911

SCIENTIFIC BOOKS

A Text-book of Botany for Colleges and Universities, by members of the botanical staff of the University of Chicago, JOHN MERLE COULTER, Ph D, Professor of Plant Morphology, CHARLES REID BARNES, Ph D, late Professor of Plant Physiology; HENRY CHANDLER COWLES, Ph D, Professor Plant Ecology. Vol I, Morphology and Physiology New York, Cincinnati and Chicago, American Book Company 8vo Pp viii + 484 + 12

When Strasburger with his colleagues in the University of Bonn brought out a textbook of botany it was promptly named the "Bonn Text-book," following which precedent it has been suggested that the book before us should be named the "Chicago Text-book" And this American book promises to be a worthy rival of its German predecessor, which no doubt it will replace in many college and university classes. When complete, the book will include morphology, physiology and ecology, but for some reason not stated in the preface, only the first and second are now published. Probably that will follow before long, as some reference is made in the preface to "Part III." as at least partly prepared for publication.

The book is doubly interesting in that it

presents a certain amount of organized information in regard to a portion of the science of botany, and also that it gives us the result of ten years of experience in working out the method of undergraduate instruction in botany in one of the foremost botanical laboratories in the country. The authors here endeavor to present "the fundamental facts and principles of the science," and they hold that these should precede the work of most other subdivisions of botanical investigation. Thus they point out that "a study of the very important subject of plant pathology must presuppose the fundamentals of morphology and physiology, paleobotany is, in part, the application of morphology and ecology to fossil plants, and scientific plant breeding rests upon the foundations laid by morphology, physiology and ecology"

Here we have then an expression of the opinion of three eminent teachers as to what should be the "content" of botanical instruction, and its proper sequence, and it is that the structure of plants must be presented first in an orderly sequence from the lower to the higher forms, and that then the activities of plants must be considered, while the relations of plants to one another and to their physical environment may well come after form and function have been pretty fully considered. Then when these fundamental subjects have been pretty well mastered the student is ready to go forward into pathology, paleobotany, plant breeding, etc The book is thus a contribution to botanical pedagogy. This aspect of the book is, we believe, most important at this time when some teachers have the notion that it makes little difference in what order the subdivisions of botany are taken up.

The morphological part plunges at once into a study of the Thallophytes, taking in succession (1) Myxomycetes, (2) Schizophytes, (3) Algæ, (4) Fungi, followed by Bryophytes, Pteridophytes and Spermatophytes, and a suggestive chapter entitled "Organic Evolution" The treatment is admirable, and the more than six hundred illustrations make this one of the most satisfactory morphological texts with which we are acquainted The student who runs up through the vegetable kingdom in the sequence here given can not fail to secure a clear conception of its general plan, as well as of its probable mode of evolution.

The second part, devoted to Physiology, takes up the subject under five heads, viz., (I) the material income of plants, (II) the material outgo of plants, (III) nutrition, (IV.) destructive metabolism, (V.) growth and movement The treatment here is as satisfactory as in Part I., and as we read the lucid sentences we are reminded forcibly of the great loss suffered by botanical science through the death of Professor Barnes We can not refrain from quoting a few sentences, both for the substance and as illustrating the forcible presentation.

> Transpiration, far from being a function of plants, is an unavoidable danger That it is a danger, a real menace to life, is almost a matter of common observation Millions of plants perish annually because the outgo of water is greater than the income A loose soil and an exposed situation, sudden extreme evaporation due to a hot dry wind and a blazing sun, or prolonged drought, are causes of death too well known to farmers in some regions Scarcely a plant escapes the loss of some parts by reason of shortage in the water supply, and in temperate regions, with the average rainfall (say 100 cm annually), few plants attain the development of which they are capable with a larger water supply The luxuriant weed of well watered ground compared with the same weed, meager and dwarfed on the dry wayside, illustrates what a menace to life and vigor is the evaporation from plants.

It is greatly to be deplored that the facile hand that penned, and the active and original mind that framed such vigorous and lucid sentences are forever stilled, and that the work here so well begun must stop, or be carried forward by others. And who is there who can take the place of Barnes?

CHARLES E. BESSEY
THE UNIVERSITY OF NEBRASKA

Attention and Interest: A Study in Psychology and Education. By FELIX ARNOLD, Ph.D. New York, The Macmillan Company.

In this volume Dr Arnold presents the results of a study of the practical aspect of his problem. "The present essay on the psychology of Attention and Interest," says the writer, "is an attempt to classify and arrange the many facts that have been brought to light by numerous experiments in the psychological laboratories" In order to allow of the fullest review of such facts the conception of attention has been made as simple as possible; as developed in the Introduction, attention is the correlative of the development of an "object" in consciousness The appearance of such an object of consciousness is not incidental to mental activity; in all developed consciousness it is its characteristic form The problem of the essay is an inquiry into the history and values of this characteristic activity of mind Attention and interest are therefore considered in their intrinsic relations as systems of ideal elements, in their conditions as phases of a teleological existence, and in their relation to concomitant or consequent physical changes

The writer's interest is thus not in giving a logical formulation to the conception of these phases of mental activity, nor in seeking the inner distinctions upon which their separation as ideal forms is based. He therefore systematically subordinates the guiding conceptions which may have lain back of an individual investigation and ignores the theoretical formulation to which it may have led, in order to utilize all established facts in the given field. "I have felt myself bound," Dr. Arnold says, "not to uphold any special theory or school, but to present the facts as they seem to be" With reference to all purely psychological problems the book may therefore be called selective; it represents a sifting of the literature with a view to presenting in a succinct review the ascertained facts concerning attention and interest, in their manifold connections, which are of importance to the teacher. As the writer's motive is not critical but practical, and as the aim is to make the reader acquainted with those special aspects of the subject which are of value in connection with the problems of the school-room, the discussion falls into two parts, first, the presentation of the results of experimentation, and second, the application of these results to school-room practise. The résumé of literature is given separately for each of the two topics, but the applications are considered in a single discussion The book thus falls into three parts: (I.) Attention, (II.) Interest, (III.) Education In dealing with each topic the writer simplifies the discussion by separating his description of the facts from their explanatory, developmental and illustrative treatments, which are considered in separate sections.

By its aim the book disarms criticism for any lack of rigid psychological criteria in the matters of definition and limitation of discussion, since it is a summary of results determined primarily by the needs of the teacher Though the psychologist may rightly demand a definition of attention, or of interest, in such terms as to limit the view to phenomena of consciousness alone, the teacher must take into account the whole psychophysical situation in which the child is placed if he aspires to stimulate his attention or direct his interest He must study the effects of extraneous stimulation, fatigue, nutritive condition and motor control, as well as those of practise, rest, age, mental development and the like. The mind's activities are both physically and historically conditioned, and their supplementation or ideal control is made possible by this correlation alone. From the teacher's standpoint it is just these extrinsic features of attention and interest—with which Dr. Arnold's book so largely deals—which are of real importance. The analysis of inner distinctions and correlations in the ideal systems themselves which may be called their intrinsic features are, as Herbart long ago pointed out, least of all to be considered in such a connection, though they may constitute the primary phenomenon for the introspective psychologist. Dr. Arnold's summary of these objective stimuli to interest, and of the physical conditions and manifestations of attention is full and well presented. In the opinion of the reviewer it is here that the

value of the book lies. The varied information which it brings together in a compendious form will be found useful by the psychological student and lecturer as well as by the teacher.

When the writer undertakes to bring his materials together in a systematic review the result is less satisfactory. It is, of course, impossible to keep clear of theory in any systematic presentation of fact, and while the necessity for such underlying conceptions may be masked so long as one is concerned only with reporting the results of individual experiments, the lack of guiding principles will appear whenever the attempt is made to bring together a group of particulars in a systematic review. Dr. Arnold's recapitulation of the discussion of attention, for example, suffers from the lack of a principle of division distinctly conceived and persistently adhered to. He begins this review by pointing out that "attention must be considered from two points of view," the sensory and the motor, a dualism which is expressed also in the terms "ideal" and physiological. The reader naturally assumes that this statement, with which the recapitulation begins, represents the last result of the writer's analysis, that the distinction is fundamental to the phenomena of attention. But Dr. Arnold goes on immediately to say that there are two aspects of attention, the subjective and the objective, of which the former includes both the sensory and the motor processes above mentioned. If this be so, it should be pointed out on behalf of the reader that the conditions of a good exposition surely require the more fundamental distinction to be presented first. That the latter distinction is basal appears from the following page, in which the subjective-objective is made the most general phase of the discussion.

The schema in question formulates the phenomena of attention in a way which is of permanent value, but as the grouping is not, in strictness, the order followed in the previous discussion, it can scarcely be called a recapitulation. One must drop the old subdivisions which he carried in mind throughout the reading, and substitute a new—though of course congruous—conception of relations. A question, too, may be raised concerning the propriety of the terms here employed. The aptness of the term "objective" to a summarization of the characteristics of clearness, distinctness and persistence may be granted, since these are, properly speaking, attributes of the object before consciousness, but a certain violence is done to a term already too loosely employed when accommodation and fixation, respiration and vaso-constriction, as well as fusion and free association, are made to fall within the field of the "subjective." Still more do the details of the schema reveal the need of logical formulation as well as of full citation of individual fact. The "subjective" aspect of attention, for example, is considered under the two heads, motor and sensory, but under the former appears also a subdivision entitled "motor," comprising the phenomena of innervation, diffusion and control. It is confusing, too, that under this term—which is not only popularly opposed to "sensory," but is also made its logical alternative in the present scheme—there should be made to fall the two subdivisions "sensory" and "motor" as minor terms. There is therefore the further contradiction that the term "sensory," which constitutes the basis of the second general division, should appear also as a special constituent of the first group of phenomena.

In each phase of the discussion Dr. Arnold has added to his description of the phenomena a consideration of their development in the individual mind. This is an important addition to the study which might profitably receive even more space than has been given to it. A series of illustrations is systematically appended to each chapter of the book. While these are in general well chosen, the reviewer finds some of them puzzling; but effective illustration is, after all, not only a matter of happy invention in the writer, but also one of idiosyncratic temperament in the reader, and the instances cited may nowhere present such obscurity to another mind.

ROBERT MACDOUGALL

SPECIAL ARTICLES

AN INTERMITTENT SPOUTING WELL

IN parts of central Florida bored wells are somewhat extensively used for drainage purposes The wells are drilled through the superficial material and as a rule enter the Vicksburg Limestone of Oligocene age, although other porous limestones may serve the same purpose Many of the wells terminate in cavities in the limestone, while others reach layers of shell or other porous material Surface water entering the wells is carried into the limestone formation. In some localities in the central part of the state these wells have been found very efficient in carrying off surface water and in draining small marsh areas for agricultural purposes

One of these drainage wells near Orlando, in Orange County, recently developed the unusual phenomenon of spouting The well was drilled in 1907 and is located near the edge of a small lake It is twelve inches in diameter and has a total depth of 260 feet, and is cased 60 feet The level of permanent underground water at this locality is 33 feet from the surface Trucking is carried on around the edge of the lake and the well is intended, by carrying off the surplus water, to prevent the lake from rising above a given level, since to do so would flood the farming land The well is similar in character to the other drainage wells of this locality and, as in the case of most of the other wells, terminates in a cavity in the limestone

The well was first seen by the writer October 4, 1910 At this time the water of the lake stood a few inches above the level of the top of the pipe, and the well was receiving water at much less than its full capacity At intervals of a few minutes the well would reverse itself and spout, throwing a column of water into the air The spouting comes on gradually First the well ceases to receive water and begins bubbling, the column of water follows, rising with considerable force to a height of twenty feet or more above the surface, the spout occurring with tolerable regularity at intervals of four minutes The manager of the farm states, however, that the interval between spouts varies from two to fifteen minutes, being probably influenced by varying conditions under which the water enters the well[1]

Although drilled three years ago and receiving water more or less continuously during that time the phenomenon of spouting developed for the first time on September 26, 1910, the first spouting having occurred about eight o'clock in the morning of that day The well continued spouting without interruption for a little more than a week and until shut off by the owner

Various fanciful theories have been advanced to account for the spouting, including supposed occurrence of gas and oil, and the supposed influence of recently formed sinks in the interior of the state The true explanation is evidently much more simple At this stage of the lake the well is receiving water at less than its full carrying capacity and as the water enters the vertical pipe it forms a suction, carrying a large amount of air into the well, which doubtless collects in a chamber or cavity along the side or at the bottom of the well As the well continues receiving water the air accumulates under pressure in this chamber until ultimately the pressure under which the air is confined is sufficient to overcome the weight of the overlying water plus the inertia of movement, and hence rushes out with considerable force, carrying the column of water with it The fact that the well when first drilled did not spout and afterwards began spouting doubtless indicates that the essential conditions were subsequently developed either by caving or by other changes in the underground conditions

When partly shut off so that only a limited amount of water enters the well the air taken into the well is able to return to the surface freely and under these conditions spouting ceases It is probable that if an elbow is placed on the well, allowing the water to enter laterally instead of vertically, the amount of air taken into the well will be so far reduced that the spouting will cease Likewise when the lake rises so that the water stands several

[1] A photographic illustration of the spouting well will be found in the Third Annual Report of the Florida Geological Survey, pl 9, 1910.

feet above the top of the pipe entering the well the spouting should cease, since the pipe will then be carrying water at its full capacity with little or no air under these conditions entering the well As a matter of fact following the heavy rains attending the storm of October 17 and 18, 1910, the lake rose several feet and the well upon being reopened received water without spouting A similar spouting well at Albany, Ga, was described some years ago by Professor S W McCallie[8]

E H SELLARDS

TALLAHASSEE, FLA

GRAPHITE IN VEIN QUARTZ[1]

THE writer has recently discovered a graphitic quartz in Troup County, Ga, which has some geological significance, since it is entirely unlikely that the graphite is directly of organic origin. The graphite occurs in massive vein quartz and, recognizing the already known occurrence of graphite in pegmatite and gneiss at other localities, affords additional evidence of the inorganic origin of graphite under peculiar geological conditions

The graphite occurs in small flakes and in irregular bunches, two or three millimeters in diameter or length, disseminated through massive, clear quartz In fact, in the specimens at hand, except for iron stains, quartz and graphite are the only components of the rock Under the microscope, minute black crystals were noted, but the black color disappeared upon ignition, leaving the crystal form intact, indicating only a covering of graphite over minute quartz crystals The graphite, roughly estimated, forms only two or three per cent of the quartz at present exposed.

The nearest rock exposed in the vicinity of the quartz vein is a peridotite and it is not improbable that the vein is cutting this rock The quartz, of course, could possibly be derived from pegmatite, but at the surface neither feldspar nor mica were found with it The vein is evidently of small dimensions

[8] SCIENCE, N S, XXIV, p 694, 1906.

[1] Published with the permission of the state geologist of Georgia

The nearest strata of certain sedimentary origin are the Pine Mountain quartzites a few miles to the southward.

Whether the quartz was deposited from an aqueous solution or is of aqueo-igneous origin, the carbon must have been held in some form in the rock solution and the graphite deposited contemporaneously with the quartz Its dissemination, not cavity filling, through compact, crystalline quartz is sufficient evidence that it is not directly of organic origin or derived from the metamorphism of carbonaceous matter Perhaps the most suggestive theory of the origin of the graphite under these conditions is that it was derived from carbon dioxide (CO_2), or a hydrocarbon vapor held in the siliceous solution The presence of carbon dioxide in crystals of quartz is well known Smoky quartz from Branchville, Conn, yielded gas, analyzed by A W Wright, which contained 98 33 per cent. of CO_2.

OTTO VEATCH

CONCERNING SEXUAL COLORATION

IN the linnet of California (*Carpodacus frontalis*), after the post-juvenal (first fall) molt, the sexes are conspicuously different in color The female is obscurely streaked beneath with hair-brown on a dull white ground, above more uniformly hair-brown The male is usually red in color, on the whole chin, throat, malar region and chest, on the frontal and lateral portions of crown, and on the rump, otherwise the male is like the female The linnet would thus appear to provide a good case of "sexual coloration."

After the post-juvenal molt, there is, in both sexes throughout the lifetime of the individual, but one molt annually, taking place in August. *There is no pre-nuptial molt.*

In a large series of male linnets, leaving out the occasional aberrant examples which are distinctly yellow or orange, striking variation is shown in the shade and intensity of the red. Arrangement of the component examples by date, from September to July, shows this variation to parallel uniformly the lapse of time beyond the annual molt in August. In

the fresh fall plumage the red is of a dull pinkish hue (burnt carmine), there is thereafter a progressive change, slow in autumn, rapid in spring, until the breeding season finds the amorous males, bubbling with song, and going through various courting antics, arrayed in brilliant poppy red.

A nuptial attire has been donned, in the male only, but there has been no replacement of feathers; nor has there been an influx of new pigment into the feather as a former most unsound theory presupposed

Microscopical examination of various feathers appropriately selected during the period of molt, when old and new feathers are to be found side by side, discloses the following facts: In the newly acquired, unworn plumage, the red pigment is restricted to the barbs of the contour portion of each feather, except for their terminal portions to a distance of one millimeter from their tips These barb ends, which thus together constitute a band terminating each feather, and *all the barbules,* are white In the extremely old, abraded (spring and autumn) feather these grayish white end portions of the barbs in the overlapping feathers, and all the barbules, have simply been broken off through attrition and lost, thus removing the grayish obscuration, and disclosing the bright red of the barbs, the tone of which has not in fact changed one whit.

Thus wear alone has accomplished the nuptial brightening of dress. A difference of structure is evident between the pigmented and unpigmented portions of the feather, the former being by far the most resistant, the latter being so adjusted in extent and texture as to become disintegrated and lost at the advent of the season of mating.

The production of color in the growing feather in August is thus clearly anticipatory; and we observe here manifestation of a most delicate structural complex, so balanced as to bring about through purely extrinsic, physical agencies, a conspicuous brightening of plumage at the season of reproduction, seven to nine months later.

The chief point to which I wish to fix attention is, that the brilliant hue of the nuptial dress is thus in reality acquired at the post-nuptial (or annual) molt, several weeks *after* the season of mating, instead of immediately preceding This fall molt period is generally considered (as by bird fanciers and poultry raisers) to be the season of the year when the vitality of the bird is at its lowest ebb. Moreover, the organs of reproduction are at this time much reduced in size, and certainly quiescent in function. It would seem, therefore, that the production of the brilliant nuptial plumage in the linnet (and similar sequence of processes and results is well known to occur in many other passerine birds[1]) is *not* directly associated with a period of excessive sexual vigor, as a current theory postulates.

J. Grinnell
Museum of Vertebrate Zoology,
University of California

THE OKLAHOMA ACADEMY OF SCIENCE

The academy held its second annual meeting at the State University at Norman, November 25–26. In spite of the fact that this was only its second annual meeting, about forty papers were read, among which were the following.

"The Human Tonsillar Band as a Protective Organ," Dr J D McLaren

"Study of Lipase," H I. Jones

"The Physical and Chemical Changes in the Burning of Clays," L C Snider

"The Road Material of Oklahoma," L C. Snider

"The Future Sources of Power in Oklahoma," C N Gould

"A Brief History of Oklahoma Geology," C. N. Gould

"Comparison of the Four Mountain Uplifts in Oklahoma," C. N Gould.

"The Oklahoma Redbeds," C. N Gould.

"The Ecology of the early Juvenile Life of the Unionidæ," F B Isely

"The Unionidæ of the Red River Drainage System," F B Isely.

"Notes of the Experimental Study of the Growth and Migration of Mussels," F. B Isely

[1] See, especially, Dwight, *Annals N. Y. Acad. Sci.*, Vol. XIII., 1900, pp. 73–360

"A Method of Treating Complex Sulphides and a few of the Difficulties in Putting it into Practise," D D Dunkin

"Glaciation in the Pikes Peak Quadrangle," C H Taylor

"The Igneous Rocks about Cold Springs, Oklahoma," C H Taylor

"The Ancestral Form of the Testudinata An Embryological Study," H H Lane

"The Stratigraphy of the Oil Region of Northeastern Oklahoma," D W Ohern

"The Present Stage of the Canadian River," D W Ohern

"The Study of American Government in the Public Schools," Clinton O Bunn

"Nationalism versus Internationalism," J H Sawtell

"The Glass Sands of Oklahoma," Frank Buttram

"Relation of Ionization to the Toxicity of Disinfectants Preliminary Report," Oscar Harder

"A Rapid Method of the Estimation of Salts in Butter Preliminary Report," G Y Williams

"A New Rapid Modification of the Iron-hæmatoxylin orange G Method for Nerve Sections," A M Alden

"The Application of Astronomy to Historical Research," Henry Meier

"The Grignard Reaction," H I Jones

"Building Stone Possibilities of Oklahoma," L L Hutchinson

"The Available Coal of Oklahoma," L L Hutchinson

"The Physical Characteristics of the Negro," Dr A C Hirschfield

"The Origin of the Concave Profile of Volcanoes," D W Ohern

"The Human Heart and Dangers that Threaten it," G T Howerton

"Post mortem Findings in a Case of Pityriasis rubra pilaris," C D Blatchley

The academy appointed a committee, of which Dr C N Gould is chairman, to consider the advisability of securing state aid in publishing the proceedings of the academy Another committee was appointed to institute a biological survey of the state Of this committee Professor H H Lane is chairman The academy is using all the influence that can be possibly brought to bear upon the people of the state to push forward the study of the various animal and plant forms before the influence of man disturbs natural conditions

The next annual meeting of the academy will be held at the Central State Normal at Edmond, November 26–27, 1911

D W Ohern,
Assistant Secretary

THE ASSOCIATION OF TEACHERS OF MATHEMATICS IN THE MIDDLE STATES AND MARYLAND

The fifteenth meeting of the association was held at the University of Pennsylvania, Philadelphia, on November 26, 1910 The program for the morning session was

Address of welcome, Edgar F Smith, vice-provost, University of Pennsylvania

Miscellaneous business

"Is the Average Secondary-school Pupil able to acquire a Thorough Knowledge of all the Mathematics ordinarily given in these Schools?" Isaac J Schwatt, University of Pennsylvania Discussion led by Rev James J Dean, Villanova College, Edward D Fitch, the DeLancey School, Philadelphia, and E B Ziegler, Conshohocken, Pa

Election of officers

Following the morning session the association was entertained at luncheon by the university

The program for the afternoon session was·

"Training for Efficiency in Elementary Mathematics," Ernest H Kock, Jr, Pratt Institute, Brooklyn

Report of the Committee on Mathematics in Continuation Schools, William E Breckenridge, chairman, Stuyvesant High School, New York City

Report of the Committee on Algebra Syllabus, Gustave Le Gras, chairman, College of the City of New York

The officers for 1910–11 are· *President*, William Henry Metzler, Syracuse University, Syracuse, N Y, *Vice-president*, Philip R Dean, Curtis High School, Staten Island, N Y; *Secretary*, Howard F Hart, Montclair High School, Montclair, N J, *Treasurer*, Mrs Clara H Morris, High School for Girls, Philadelphia, Pa, *Council Members*, Paul N Peck, George Washington University, Washington, D. C, Susan C Lodge, Philadelphia Collegiate Institute, Philadelphia, Pa, Eugene Randolph Smith, Polytechnic Preparatory School, Brooklyn, N Y, Isaac J Schwatt, University of Pennsylvania, Philadelphia, Pa; Clifford B Upton, Teachers College, New York City, Fletcher Durrell, Lawrenceville School, Lawrenceville, N J

Howard F Hart,
Secretary

SCIENCE

FRIDAY, JANUARY 13, 1911

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THE BROADER ASPECTS OF RESEARCH IN TERRESTRIAL MAGNETISM[1]

IT has become the custom—fortunately or unfortunately as the case may be—that the retiring presiding officers talk on a particular subject, announced some time ahead, instead of being permitted to indulge in merely general reviews, as is the case in some organizations Before I had a chance to think definitely on the matter, request was received from the permanent secretary four months ago that the title be furnished him at the earliest possible moment

My original desire was to have the opportunity of talking to you on some more general subject than the one I have finally chosen The topic, magnetism in general—a review of our fundamental ideas, the status of researches on the question "What is a Magnet"—appealed to me strongly In connection with my researches in terrestrial magnetism, I have naturally been obliged to look occasionally out beyond and raise questions on the general problem of magnetism. When not only the permanent secretary, but the secretary of this section and the present chairman, began to make inquiries as to my subject, I had to settle upon something And when I turned to your chairman for assistance in coming to a decision, and submitted to him several topics, *e g*, "The General Problem of Magnetism," "The Physical Bearing of Problems of Terrestrial Magnetism," etc, he indicated his preference for one relating

[1] Address as retiring vice-president and chairman of Section B (Physics), American Association for the Advancement of Science, given at Minneapolis, Minn, December 29, 1910

to terrestrial magnetism, for he said, "A man usually talks best on the subject he knows best" Note the diplomatic and graceful manner in which he intimated to me that I might possibly know a little more as to the earth's magnetism than of magnetism in general However, since magnetism is one of his own particular fields of research, may we not hope that he will decide to talk to us about this broad subject himself when he reaches the retiring age?

In fact, I am quite ready to confess ignorance of the most absolute kind on the whole subject of magnetism, terrestrial as well as general And I am all the more willing to do so because I find myself in excellent company Was it not von Helmholtz who characterized "magnetism as the most puzzling of natural forces"? Did not Rowland say that next to gravity, the greatest problem is that of terrestrial magnetism? Was it Lorentz who said that our ignorance in magnetism is the disgrace of modern physics, or words to that effect?

On the whole, it perhaps does seem best that one should talk, as far as he can, on an occasion like this, concerning a subject from his own directly acquired knowledge As a retiring president of the British Association some years ago aptly said, when apologizing for confining himself chiefly to his own immediate subjects instead of attempting a complete general survey of the progress of science "Partial views are better than inexact ones, and provision is made for their completion in the annual change of your officer"

I must take it for granted that I owed the honor of my election as vice-president and chairman of this flourishing section, two years ago, to the fact that it has been my privilege to contribute something towards the stock of our knowledge of the earth's magnetism I may therefore assume that you want me in the first instance to "reveal myself in my own subject" I will then only ask one favor of you in return, that you allow me to omit more or less wearisome details and deal to-day only with some of the broader aspects of terrestrial magnetic research

Professor Arthur Schuster, during his visit to Washington last September, one day remarked jokingly to the speaker, "I am not quite sure whether it has really been best to have a special journal on terrestrial magnetism for gathering in the chief papers For when no such organ existed physicists *saw*, at least occasionally, an article on the subject in their journals, even if they did not read it" The presumption evidently was that physicists nowadays have less opportunity for imbibing knowledge on terrestrial magnetism and kindred subjects

So then, if I, a *terrestrial* magnetician, may be pardoned for knowing but little of magnetism, or, for that matter, of physics in general, possibly the *pure* magnetician or the pure physicist would likewise in turn have a valid right to ignorance in terrestrial magnetism and cosmical physics, were it not for the contradictory fact that he is often found to be the author of our encyclopædia articles on these very topics His wisdom in these particular fields appears to be gained in that wholesome and unwearisome manner employed by Herbert Spencer, who "never began by attempting to learn what had already been said." "All my life," said he, "I have been a thinker and not a reader, being able to say with Hobbes that 'if I had read as much as other men, I should know as little as they.'"

We are to spend a few moments together to-day in looking at some of the broader aspects of physical research in a field that, with justice, many of you may look upon

as an exceedingly special and restricted one and perhaps even question its right to be classed among the physical sciences And yet this subject of the "earth's magnetism," which may consider itself fortunate if a brief section is devoted to it in the average text-book of physics, is itself so broad and so extensive that I know of no single investigator who could to-day be regarded as equally eminent in all its various branches and sub-branches To be a master in terrestrial magnetic research requires the most intimate knowledge of several of the so-called fundamental sciences, especially of mathematics, physics and geology, with some knowledge of astronomy, meteorology, chemistry and geography besides "The field of investigation," says Maxwell, "into which we are introduced by the study of terrestrial magnetism, is as profound as it is extensive"

MAGNETIC DISTURBANCES

Instead of beginning with the phenomena usually chosen to illustrate the earth's magnetism, let us begin with one of the irregular, more or less spasmodic manifestations—one of the so-called "abnormal features"—the earth's "magnetic storms" as they were termed by Humboldt Because of the troublesome nature of magnetic disturbances, when one is dealing with a phenomenon like the diurnal variation, for example, various magneticians for nearly three quarters of a century have been seeking some logical method of deciding just at what point a disturbance begins —in brief, how large must be the fluctuation in a magnetic element to be classed and eliminated as a "disturbance" Various rules have been set up, but none has found general acceptance

There was a time when it was thought that, by mere inspection of the photographic record of the variations of a magnetic element during the day, it was possible to say whether that particular day was disturbed or not, and so arose in Great Britain, for example, what are called the "astronomer royal's five quiet days during the month" Through Airy's initiative, the first English magnetic observatory was established at the Greenwich Observatory during that period of intense magnetic activity which prevailed in the first half of the last century—during the days of Humboldt and Gauss The honor of deciding on the five quietest days in any particular month from which the "normal" diurnal variation may be deduced, has therefore been accorded to the head of the Greenwich Observatory, these days are selected by him, or more likely by his magnetic assistant, from a mere inspection of the photo-magnetograms However, it has been found that these supposedly quiet days may themselves be subject to a more or less constant disturbance which, prevailing throughout the day, serves to elevate or depress the entire curve and hence does not reveal itself in superposed serrations or "eruptions" Or the disturbances may follow somewhat the same course as the diurnal variation itself, and hence again not be revealed by mere inspection, but serve mainly to increase or decrease the diurnal range

Van Bemmelen and Chree have also found that these supposedly quiet days are subject to a non-cyclic effect similar to that shown by other days I recall that during my first magnetic survey—that of Maryland, 1896–99—there were months when a searching examination of the photographic records of the magnetic observatories showed that there was hardly a day out of a whole month without some kind of irregularity.

It is then evident that a phenomenon which occurs so frequently and which in

fact appears ever to be present in some degree, at least, in the prevailing magnetic condition of the earth, is hardly to be treated as an outcast or as an "abnormal" feature I very much question whether it will ever be possible to set up any rules which will separate scientifically the supposedly abnormal from the supposedly normal fluctuations of the earth's magnetism I am rather inclined to believe that as progress is made there will be fewer and fewer attempts in this direction On the contrary, *instead of eliminating a disturbance because it will not fit in with a particular mold or pattern, we shall learn that knowledge is mostly to be advanced by retaining it*

In order to have something definite with which to deal I am going to ask you to confine your attention to-day chiefly to the abruptly beginning magnetic disturbances, bearing in mind, however, that not all magnetic storms begin thus The first interesting question which arises regarding these sudden storms is whether, if referred to universal time—say, Greenwich mean time —they begin, within the limits of measurement, at the very same instant over the entire globe, or at least over a great portion of it Up to the beginning of this year it was, indeed, generally believed that there was no measurable interval between the times of beginning of sudden disturbances even for very distant stations The opinion was that the time differences which were revealed were only apparent ones, not real—that, if there were no errors of observation, they would vanish So the belief arose that it might be possible to find the longitude between two distant stations by determining with the utmost accuracy the local mean times of identical perturbations, for, be it remembered, even the very smallest of these find their counterparts frequently at very remote stations.

A magnetic effect propagated with the velocity of electromagnetic waves would require but one eighth of a second to pass completely around the earth, if with the speed of a cathode ray, the circuit time would be on the order of a half or three fourths of a second If then magnetic disturbances were propagated over the earth with such velocities, our present instrumental means would not suffice to detect any time differences between stations, though on opposite sides of the earth If, however, differences of whole minutes are found instead of only fractions of a second, it will at once be seen that a most valuable clue has been obtained towards disclosing the nature and origin of our magnetic storms It is my belief, furthermore, that *a long step forward will have been taken towards the solution of the origin of the earth's magnetism when once we have found out what causes it to vary*—what it is that can derange the magnetization of our entire planet to the extent of ten to twenty per cent in the brief interval of a quarter of an hour, as actually occurred during the magnetic storm of September 25, 1909, the most notable of which we have any record Referring to changes in the earth's magnetism, insignificant alongside of those just mentioned, viz, the secular changes, which only reach a comparable amount when integrated over a period of several centuries, Maxwell says: "When we consider that the intensity of the magnetization of the great globe of the earth is quite comparable with that which we produce with much difficulty in our steel magnets, these immense changes in so large a body force us to conclude that we are not yet acquainted with one of the most powerful agents in nature "

I would now like to call your attention to some interesting facts found with regard to 38 of these sudden disturbances which

occurred during the years 1882–1909 No 1 of these is the unique magnetic disturbance of May 8, 1902, which, as far as can be ascertained, occurred simultaneously with the destructive eruption of Mont Pelé On account of this interesting coincidence the records of twenty-five observatories in different parts of the world were collected and studied in my office When the various scalings of the time of beginning of the disturbance were put together, they appeared to increase to the east, the effect apparently having been recorded first in Europe, next in Asia and last in America The speed of progression was such that a continuous circuit of the earth around a great circle would require nearly 4 minutes, or in other words, the velocity was on the order of 100 miles per second or only about one two-thousandth that of light

No 2—the disturbance of January 26, 1903—was one investigated by the eminent physicist-magnetician Birkeland, the author of the cathode ray theory of magnetic disturbances. For this again an easterly progression, on the same order as for No 1, was found

Next, Nos 3–19 are 17 storms between 1882–89 which were investigated by William Ellis, who was for a half-century in charge of the magnetic work at Greenwich.

The nineteen cases thus far mentioned showed a remarkable consistency in the direction in which the times increased, viz, to the eastward, only one sixth showing the reverse direction

In order to test this result further with the aid of the best data immediately available, Mr. R. L Faris, Inspector of Magnetic Work of the United States Coast and Geodetic Survey, undertook, at my request, a special examination of fifteen sudden storms between 1906 and 1909. He had to restrict himself for the time being to the five magnetic observatories belonging to the United States, viz, Cheltenham (Maryland), Porto Rico, Baldwin (Kansas), Sitka and Honolulu, which extend over about one quadrant of the earth Mr Faris scaled the times of beginning with every possible care, he estimated that the error of measurement was about one half minute and certainly not over one minute Yet the individual observatories differed by quantities ranging from 1 1 to 6 7 minutes! Here again, for 10 out of 15 cases, the direction of progression, over the limited portion of the earth embraced, was eastward, and for only one third was it westward.

The next four cases are some tiny preliminary disturbances preceding larger ones, investigated by the director of the Zi-ka-wei Magnetic Observatory, Father J de Moidrey, and by Mr Faris, for two of these the direction of progression was east, and for two, west

Summarizing—for 28 out of the 38 cases the times of beginning increased eastward and for but 10, or about one fourth, the increase was in the reverse direction The following conclusion was accordingly drawn

Magnetic storms do not begin at precisely the same instant all over the earth. The abruptly beginning ones, in which the effects are in general small, appear to progress over the earth more often eastward though also at times westward, at a speed of about 100 to 200 kilometers per second, so that if a complete circuit of the earth were made it would require, on the average, between 7 and 3 minutes.

DIRECTION OF MOTION OF MAGNETIC DISTURBANCES

If it is a fact that magnetic disturbances are propagated more decidedly in one direction than another and that they dif-

fer, in this respect, from seismic disturbances which proceed in all directions from the center of disturbance, then a harmonic analysis of the disturbance effects should furnish further evidence. A definite electric or magnetic system must be accompanied by equally definite effects on our suspended magnetic needles. Knowing the latter, we ought, in turn, to be able to determine the general character, at least, of the producing system.

The beginning of the disturbance of May 8, 1902, may be taken as typical of the general type of perturbation thus far considered, viz., an increase in the horizontal intensity over the whole, or at least the greater part, of the earth, and a decrease in the vertical intensity in the northern magnetic hemisphere, and an increase in the southern. Applying a mathematical analysis, it is found that the system of forces which could produce the observed disturbance was a two-fold one—the first, the stronger, consisted of a set of electric currents in the upper regions, circulating eastward around the earth, if negative currents, and the reverse, if positive ones; the second, a weaker system, contained within the earth and possessing the characteristics not of an induced electric system, but of directly induced magnetism of the same sign as that of the earth's own field.

Please note that according to this analysis the disturbance system is chiefly an overhead set of currents proceeding, if negative ones, in an eastward direction around the earth—but this, in fact, is the direction in which the recorded times of beginning of the disturbance were found, in general, to progress. One method of investigation thus independently supports the other.

How may we suppose that negative electric currents are brought about in the regions above us which could thus affect our magnetic needles? If the progression in the times of beginning of the effect may be interpreted as meaning that, whatever the cause, it is moving with a velocity measured by the differences in the times at distant points on the earth, then the resulting velocities are on the order of about one two-thousandth that of electromagnetic waves, or about one four-hundredth that of cathode rays. The question immediately arises—May not the required overhead negative electric currents be brought about by rapidly moving electric charges, whose accompanying magnetic perturbations are but an exhibition of the Rowland effect on a scale far transcending any laboratory experiment within the power of man? We may be dealing with ionic charges set in motion, as the result of a releasing action from some quarter, by sources of energy already existent in the regions above us, whence currents arise—

> "Of power to wheedle
> From its loved north the subtle needle,"

as Maxwell said with regard to the convection currents, which "that doughty Knight, Rowland of Troy, did obtain."

Now before indulging in a bit of scientific imagination, let me caution you to distinguish carefully between what is fact and what is hypothesis. The results communicated respecting the differences and progression in the times at which sudden perturbations occur, as well as those derived from the mathematical analysis of the recorded effects, are independent of theory. You may not agree with me in any hypothesis which I may attempt to establish as to the cause of magnetic disturbances and the *modus operandi*, but please remember that the facts remain, however difficult may be the problems which they present.

HYPOTHESIS OF IONIC CURRENTS

According to the measurements of Rutherford and Zeleny, the average total ionic velocity for dry air at the earth's surface and an electromotive force of one volt per centimeter, is 3.2 cm./sec. At this rate it would take forty years to encircle the earth. Putting together all the facts of laboratory experiments at present available to me, including the work carried out at the laboratory[3] here by Zeleny and Kovarik, a provisional calculation appears to show that, for the atmospheric pressure prevailing at about the height of 75 kilometers, the ionic velocity would be of the order required for a circuit of the earth in about four minutes—hence, of the order found above to correspond with progression of the observed times of beginning of a sudden magnetic perturbation.

A mathematical analysis of the magnetic observations made at various points on the earth's surface has revealed the existence of a definite system of atmospheric electric currents whose magnetic effects are of sufficient magnitude to require their being taken into account when determining the so-called magnetic constants of the earth. Now if the atmosphere is made more conducting at any point, as the result, for example, of the ionizing effect from solar radiations, an extra current will be started and set in motion by the electromotive force existing at that point. The direction finally followed by the extra current will, however, not depend alone upon the prevalent electromotive force, but also upon the deflecting effect of the earth's magnetic field and of the earth's rotation on the electric carriers, and doubtless upon a variety of other conditions.

If a negative ion is set in motion at a given altitude in an eastward direction, the deflecting effect of the earth's magnetic field will be to bring it down closer and closer to the earth. But the ionic velocity decreases with decrease of altitude, hence the magnetic effect produced by the moving charge on a needle at the earth's surface will begin later and later, as the charge travels eastward. If, on the other hand, the negative ion starts westward around our planet, then the deflecting effect of the earth's magnetic field would be to make the charge move higher and higher and, hence, faster and faster. We might thus possibly have the following state of things. Due to some cause, electric charges are set in motion in every direction from a certain point overhead. Those with an easterly component of motion have their velocities checked in the manner just described, whereas those with a westerly component are made to move faster, so that for two stations, one east and one west, the magnetic effect is recorded later at the east station. This deduction you will observe would correspond with that actually found for the vast majority of the 38 disturbances above treated. In brief, the deflecting effect of our own magnetic field would be favorable towards the maintenance of easterly progressing negative ions, since by bringing them closer to the earth their effect is increased, and unfavorable for the westerly ones since they are made to move farther and farther away from the earth. Whether it is due to this fact that a sudden disturbance progresses more often to the east than to the west is an interesting query.

[3] The Physical Laboratory of the University of Minnesota.

THE PECULIAR MAGNETIC DISTURBANCES OF DECEMBER 29–31, 1908

I want to make you acquainted next with another set of most instructive magnetic disturbances which differs from the kind previously considered in several important

respects The effect of the previous type of disturbance was to superpose, on the earth's existing magnetic field, a subordinate magnetic system possessing essentially the same characteristics as the primary field, differing from it only in degree—in brief it *increased* momentarily the earth's magnetization, and hence might be termed a "positive magnetic perturbation" It was also a world field—its effects were recorded all over the earth

But now we are to have examples of a "negative magnetic perturbation," whose effect is to superpose a magnetic field opposite to that of the earth, in short, diminish the earth's prevalent magnetization, and whose area of action is a comparatively restricted one These perturbations were not felt over the whole earth within a few minutes of the same absolute time, instead the intervals between the recurrences in different parts of the earth were to be measured by hours and even a day

Attention was first called to these peculiar magnetic disturbances by D L Hazard, of the United States Coast and Geodetic Survey, and recently R L Faris, of the same organization, has collected information regarding them from a large number of observatories over the globe These disturbances did not extend much over one half hour and occurred on a practically undisturbed day The maximum deflection in the horizontal component of the earth's magnetic intensity amounted to about one five-hundredth part The complete data will be found given by Mr Faris in the March, 1911, issue of *Terrestrial Magnetism and Atmospheric Electricity* I am indebted to him for the privilege of making use of his data in advance of publication

Four times out of eight cases the region over which the disturbance prevailed was the American continent and the Pacific Ocean as far as Honolulu, in one case the region was limited to the Atlantic Ocean and the American continent, twice it occured in eastern Asia and but once in Europe Hence, had we been obliged to rely solely upon the magnetic records from the region of the earth, Europe, where the majority of magnetic observatories exist (about 20), we should have had to report but one magnetic disturbance between December 29 and 31, 1908, instead of actually eight No fact known to me illustrates more convincingly than this the folly of increasing greatly the number of magnetic institutions in the same region of the globe It also proves that, when dealing with general terrestrial magnetic phenomena, no such weight can be attached to the combined testimony of the European observatories as has heretofore been the custom To give weight, as is frequently done, according to the *number* of existing magnetic institutions in any one region leads to totally erroneous results We are reminded of the wise words of Joseph Henry which, though uttered in a different connection, apply with special force here, viz, "*Votes in science should not be counted, but weighed*"

Now why is it that these particular magnetic perturbations were confined each time to but a portion of the globe? The intervals in time between the successive occurrences range from $1^h 5^m$ to $24^h 21^m$, whereas the apparent velocities shown over the area covered at any particular appearance of the disturbance is on the order of the quantities as previously found for the first type of disturbance considered The question immediately arises, therefore, as to whether we are dealing here with *two* velocities Have we, for example, a vortex consisting of very rapidly moving electrical charges, an earth-spot, as it were, the vortex as a whole, however, moving

comparatively slowly over the earth? Or, are we to suppose that at each recurrence the disturbance was formed anew? No matter what view we adopt, it is evident that we are about to find out another important fact.

Determining the local mean time of the extreme stations at which the disturbance was recorded whenever it occurred, it is immediately seen that *only the observatories in the daylight zone were affected* At those observatories where the local time was somewhere between 4 P.M. and 6 A.M., no effect was obtained Hence, the conclusion is inevitable that *solar radiations of some kind must have played an important part in the production of these disturbances* There were at the time on the sun's visible disk some peculiarly eruptive spots which may have to be held responsible for the peculiar magnetic disturbances

A mathematical analysis of this type of magnetic perturbation is at present under way, but it has already become sufficiently evident that we are dealing here with a much more complex system than in our first type.

GENERAL DEDUCTIONS RESPECTING MAGNETIC DISTURBANCES

From the two types of disturbances considered it has been found that not only may our most sudden magnetic disturbances begin at measurably different times for various points on the earth's surface, but also that magnetic perturbations may even be confined to but a very limited portion of the globe

The possibility of a regional magnetic disturbance was foretold with the aid of a law which I found to hold regarding magnetic changes in general:

"*Alterations in the earth's magnetic condition, whatever their nature or origin may be, appear to be distributed over the globe according to a law profoundly dependent upon that governing the distribution of the earth's own primary magnetic forces*"

The prediction made on the basis of this law last spring, before the facts had become known respecting the disturbances mentioned, was as follows:

> I confidently expect, as soon as a complete analysis has been made of magnetic disturbances covering the greater portion of the earth, it will be found, that the disturbance field, in general, presents all the characteristics of the terrestrial, primary one, the disturbances will themselves reveal effects from terrestrial, continental, regional and even local causes (earth currents, for example, whose path and intensity depend upon local character of soil, etc)

Were this the place, I should like the privilege of setting before you the full import of this law How, for example, we find characteristics in the magnetic fields composing the so-called permanent magnetization of the earth analogous to those which represent the systems producing the time variations Suffice it to say that, if we were to establish a mathematical expression for the respective systems involved, the same terms would appear in the space variations as in those of the time. We might tersely put it thus "*In terrestrial magnetism space and time are often relatively interchangeable*"

Before leaving the subject of magnetic disturbances let me point out to you two or three additional interesting facts which may serve to guide us in our study of causes.

It is the usual custom to exhibit the dependency of the fluctuations in the earth's magnetic condition during a sunspot cycle by means of changes in certain particular magnetic elements, as for example, the change in the amplitude of the diurnal variation during the sunspot cycle, this amplitude increasing with increased solar

activity If, however, we make use of a more direct physical quantity, viz, the earth's magnetic moment, or let us say intensity of magnetization per unit volume, then we find that, *in general, during a sun-spot cycle the earth's magnetization decreases with increased solar activity* In brief, on the average, the effect of magnetic perturbations is to superpose on the earth's magnetic field a magnetization opposite to that of its own, and hence the effect is one of demagnetization The quantity involved is on the order of that found some years ago when I raised the question as to whether the earth is gaining or losing magnetism

This question was attacked in two different ways, first, use was made of the existing magnetic charts between 1840 and 1885, secondly, freshly accumulated data between the years 1890 and 1900 were utilized Both investigations led to the same result, viz, that *the earth's magnetic moment is at present being diminished by about one twenty-four hundredth part annually* Now, if the terrestrial magnetician were permitted to make the same apparently violent extrapolation as is indulged in by the radio-physicist, he would find that, at the present rate of decrease, the earth's magnetic moment will have dwindled to one half of its present value in about 1,660 years from now Note that this period is practically the same as that of radium decay—probably a mere coincidence!

We may make use of magnetic perturbations in another way, mainly, to get some idea of the *earth's magnetic permeability* I have already pointed out above that when analyzing the effects of the magnetic disturbance of May 8, 1902, it was found that there were two systems involved, one an external one composed of overhead electric currents, and the other, an internal one having the characteristics of directly induced magnetism If we suppose that the second system is the result of the first, then the ratio of the potentials of the two systems will give us the differential change in the earth's magnetic permeability Various calculations of this kind are under way

One of the most important bearings of the facts above set forth regarding magnetic disturbances pertains to the slow, progressive changes to which the earth's magnetization is subject—secular changes It has already been hinted above that these *secular changes can not be explained simply by a change in the direction of the axis of magnetization, but likewise imply changes in the intensity of magnetization* Respecting the latter, our result was that apparently the residual effect of a magnetic disturbance is a diminution of the intensity of magnetization, which may last for some period after the cessation of the disturbance, two months, for example, as occurred with respect to the notable magnetic storm of September 25, 1909 Whether the earth ever recovers completely from a magnetic disturbance is questionable

Now, *as to the effect of magnetic disturbances on the axis of magnetization,* let me merely point out that if magnetic disturbances do actually in general progress over the earth more often in one direction than in the other, the mechanical effect is to be reckoned with If the progression is generally eastward, as appears to be the case, then the mechanical effect of the overhead currents will be to increase the velocity of the earth's rotation or, failing to do that, which is more probable, the effect will be to cause a displacement of the earth's magnetic axis eastward. We thus have disclosed to us one of the several systems causing the secular variation of the earth's magnetism which was pointed out in 1904

as the result of my analysis of the systems causing the secular variation

The principal system, however, involved in the production of the secular variation is still to be revealed, and a promising line of inquiry, at present in progress, is the concomitant study of the laws followed by the secular variation and the lunar diurnal variation of the earth's magnetism, I have found that both follow remarkably similar laws in their distribution over the earth It might also be mentioned here that owing to the non-commensurability in the periods of the solar-diurnal and the lunar-diurnal variations, there is an outstanding daily residual of the right magnitude for the production of the secular variation

Sufficient has been given to show how important and fruitful is the study of the "abnormal" features of the earth's magnetism It seems probable that we shall learn more from a close investigation of magnetic disturbances—of the irregular phenomena—than of the normal and regular features In any event we find that the "abnormal" is such an intimate part of the supposedly "normal" that it seems unwise really to make a separation We fully endorse the view of Schuster when he says

> Outbreaks of magnetic disturbances, affecting sometimes the whole of the earth simultaneously, may be explained by the sudden local changes of conductivity which may extend through restricted or extensive portions of the atmosphere I have shown in another place that the energy involved in a great magnetic storm is so considerable that we can only think of the earth's rotational energy as the source from which it ultimately is drawn

According to the views above set forth, the various manifestations of solar activity, sunspots, protuberances, etc, are not the direct but the indirect cause of the earth's magnetic storms Their effect appears to be more in the nature of a releasing or "trigger" action, setting in operation electric forces already in existence in the upper regions of the atmosphere, terrestrial sources, in reality, however, supply the energy required for the magnetic storm

THE EARTH'S PERMANENT MAGNETIC FIELD

Our studies began with magnetic disturbances, and we soon found that we were dealing with systems of forces remarkably similar to those composing the earth's permanent magnetic field Given an existing electrical field in the upper regions, it follows at once, from our knowledge of the necessarily varying conductivity of the atmosphere resulting from solar radiations of various kinds, that this field must be an exceedingly variable one First, it must be subject to a daily variation of an average normal kind corresponding to the average normal solar radiation, and superposed on this more or less spasmodic fluctuations, which represent the variability in the supply of the essentials in the solar radiations for producing the observed magnetic effects

In this connection let me point out an interesting bit of evidence furnished during the time of the total solar eclipse which occurred in the United States in May, 1900 As the result of the special magnetic observations, made chiefly by the observers of the United States Coast and Geodetic Survey, a small magnetic perturbation revealed itself at each station along the belt from Georgia to Maryland This perturbation did not begin according to absolute time nor according to local mean time, but bore a distinct relation to the time of passage of the shadow cone It was thus shown that by the interposition of the moon between the sun and the earth, certain radiations were cut off as the result of which a magnetic fluctuation was produced I recall that the late Professor Newcomb appeared rather skeptical as to

the possibility of a magnetic fluctuation due to such a cause until one day he put this query to me "If a magnetic effect is produced when such a small body as the moon comes between the sun and the earth, why do we not have an effect every day owing to solar radiation being cut off from one half the earth by the other?" Professor Newcomb had momentarily forgotten that we do have a daily effect of the very kind he had in mind, viz., the diurnal variation, and when I pointed this out to him he appeared convinced as to the possibility of a magnetic effect likewise during a total solar eclipse I have shown that the magnetic effect during a total solar eclipse is precisely similar to that of the diurnal variation, differing from it only in degree and that the amplitudes of the respective oscillations are in direct proportion to the areas of the interposing discs

Please recall also that in the second type of disturbance above treated, viz., those of December 29–31, 1908, we had further evidence of perturbations occurring only in the daylight zone, the inhabitants on the other side of the earth did not experience the perturbations

If then so much can be explained or, let us say, suggested, on the supposition of an existing primary electric field in the region above us, then it behooves us to do our utmost to find out all we can as soon as possible regarding this field And here is where the great value of the extensive magnetic operations of the Carnegie Institution of Washington will be demonstrated, for the precise characteristics of that outside electric field can not be accurately determined until the completion of a general magnetic survey of the globe When that has been accomplished, which we hope will be the case within the next five or ten years, then the constants, or rather the determining coefficients, can be derived for the various constituent portions of the earth's total magnetic field.

Before closing this section let me call to mind a fact that is frequently overlooked, that *our only cognizance of the earth's magnetic field is through its external lines of force* Cut these out, and we would conclude, in accordance with our usual test, that the earth was not magnetized But we might have closed magnetic systems within the earth similar to that of a magnetized ring Such a ring, however strongly it may be magnetized, has no outside magnetic effect and if we had no previous knowledge of its internal magnetization, we would conclude from our usual experiments that it is non-magnetic I know of no method of disclosing such magnetizations as that of the ring without producing some mechanical change in the ring itself. Accordingly, our knowledge of the earth's primary magnetism would be confined wholly to external effects, were it not for the fortunate fact of the variations continually caused in the earth's magnetism by outside forces You will therefore see the point to my statement that, in my belief, *it is useless to attempt an explanation of the origin of the earth's magnetism until we have found out what causes it to vary.* Perhaps even then it may turn out that we shall have to be content with simply raising the question already put by Schuster whether "every rotating mass may not be a magnet."

In this connection let me record here an interesting fact which I found some years ago If we determine the earth's magnetic axis and intensity of magnetization per unit volume separately for various parallels of latitude, then there is a distinct connection shown in the values of the constants involved with the speed of rotation of a particle on the parallel concerned.

A BROAD VIEW

I began my address by setting before you some of the results of research in a field which I am ready to acknowledge appears, as I have already said, a very restricted and special one But as we progress we are continually forced to raise questions which go far beyond our specialty and touch at the very heart of matters in which we all take a common and lively interest

The all-comprehensiveness of terrestrial magnetic phenomena makes us more than ever aware of the necessity of taking broad views and keeping our minds ever open and free so that we may receive and weigh the facts observed with the proper care and in the proper scientific spirit

The terrestrial magnetician is continually having forced upon him the fact that the "axis of the universe does not stick out of his own back yard" He can not follow the example of his more fortunate brother, the geodesist, who, from careful measurements made over but a very limited portion of the earth can determine its figure with wonderful precision, the best possible demonstration of which we shall have today from the address of the retiring chairman of Section D To the geodesist a mass of lead is the same as an equal mass of magnetic iron ore, not so, however, to the magnetician Were he to attempt the determination of the position of the earth's magnetic axis and of the earth's magnetic moment from a series of extensive magnetic observations in the United States, he would obtain results totally different from those similarly derived for an area of equal size in some other part of the globe So likewise, as we have found with respect to the earth's magnetic disturbances, five well distributed magnetic observatories can accomplish more, viewed from a general, terrestrial standpoint, than twenty of the best equipped magnetic observatories concentrated in but a limited portion of the earth, however civilized that portion may be

Thus the student of magnetism has difficulties not encountered in geodesy, and he would appear to suffer under great disadvantages. Perhaps, however, the disadvantages under which he labors as regards one object may become a source of advantage in a totally different one, by the very fact that to the magnetician a lump of iron is different from a similar mass of lead he is enabled to draw certain conclusions with regard to the materials forming the earth, denied to the geodesist One of our foremost geologists has predicted that our knowledge of the internal constitution of the earth is to be advanced primarily through terrestrial magnetism and seismology

Beginning with Gauss and up to within comparatively a few years ago, it was believed that it would be possible to establish a mathematical expression having a limited number of coefficients which would represent the magnetic observations made over the earth's surface, if not entirely within an error of observation, certainly within an error of approximately the same order However, as carefully conducted magnetic surveys become more extensive, it is becoming more and more evident that it is useless, for practical purposes, to establish such mathematical formulas Were we, for example, to have magnetic data all around the globe at intervals of five degrees in latitude and longitude, hence at 72 points on a parallel, it would be possible to set up a formula which should represent absolutely the values at the points given, but even for this case the expression would involve so many unknowns as to make the computation practically prohibitive. And after all this labor had been accomplished, it would not be possible to obtain the mag-

netic elements between the five-degree points and within the accuracy attainable even by ocean magnetic work. In fact the outstanding residuals would be on the order of 10 to 100 times the error of observation. This inability to represent the earth's magnetic condition by means of a closed mathematical formula having a definite physical interpretation might again be looked upon as a disadvantage. I, however, am inclined to look upon it as an advantage, for we have thereby a definite proof of the fact that magnetic observations are sufficiently delicate to disclose all of the heterogeneities and irregularities in the constitution of our earth. Had we time we might profitably spend a few minutes in looking at the testimony which may be furnished the geologist in this respect by the magnetic needle.

In conclusion permit me to refer to an incident which occurred at the meeting of the British Association held at Bristol in 1837. Sir William Hamilton, attending the session of the Chemical section and getting into a quarrel with his chemical brethren, remarked: "The nearer all the sciences approach Section A (mathematics and physics), the nearer they would be to perfection." I would make but one slight alteration in this assertion, namely, that the nearer we all approach to mathematics and *cosmical* physics, the nearer we should be to perfection.

L. A. BAUER

THE CARNEGIE INSTITUTION
OF WASHINGTON

CHARLES OTIS WHITMAN

PROFESSOR CHARLES OTIS WHITMAN, head of the department of zoology of the University of Chicago, died of pneumonia after a brief illness on December 6, 1910. He was born in Woodstock, Maine, December 14, 1842. He received the degree of A.B. from Bowdoin College in 1868, and A.M. in 1871. From 1869 to 1872 he was principal of Westford Academy and in 1872 was teacher in the English High School of Boston. A few years later he was studying zoology with Leuckart in the University of Leipzig and received the degree of doctor of philosophy from this university in 1878. From 1880-81 he was professor of zoology in the University of Tokio, and in 1882 we find him studying at the Zoological Station of Naples. From 1883-85 he was assistant in the Zoological Laboratory of Harvard University and was then appointed Director of the Allis Lake Laboratory at Milwaukee (1886-89). He was then called to the charge of the department of zoology of the newly founded Clark University, and in 1892 he became head of the department of zoology in another newly founded university, the University of Chicago, which position he held until his death, being thus associated with the whole of the formative period of this institution. He was the first director of the Marine Biological Laboratory, from 1888 to 1908, and established the policy of the institution. He was founder and also editor of the *Journal of Morphology*, the *Biological Bulletin* and the Woods Hole series of Biological Lectures. He was the chief organizer of the American Morphological Society, now the American Society of Zoologists, and was its president for the first four years. He was also a devoted teacher of advanced students many of whom now occupy important academic positions in this country. He was a member of many scientific academies and societies, and received the honorary degrees of LL.D. from Nebraska in 1894 and Biol.D. from Clark University in 1909. Among the subjects that occupied him during a life of intense activity in biological research were the embryology, morphology and natural history of leeches, the morphology of the Dicyemidæ, the embryology of the bony fishes, evolution of color characters in pigeons, natural history of pigeons, hybridization and heredity in pigeons, and studies in animal behavior.

Professor Whitman's life was devoted entirely to scholarly ideals of biological research

which he sought to realize with rare singleness of purpose Not only did he devote himself to personal research with extraordinary enthusiasm and thoroughness, but he had an almost prophetic comprehension of the ways and means for furthering biological investigation, and he was able to secure the cooperation of his colleagues in his enterprises by virtue of a personality that was both singularly winning and compelling In 1887 he founded the *Journal of Morphology*, now in the twenty-second volume, for the publication of research in zoology, and established it at once on so high a plane that it took rank with the foremost journals of zoological research of the world It has since served as model for newer research journals in America In 1888 he was called to be director of the Marine Biological Laboratory of Woods Hole, then newly established, and presided over its fortunes for a period of twenty-one years, during which time it came to be the leading center of biological research in America with a unique and interesting form of organization described more particularly farther on Before any one else in America, he also urged the need of the establishment of an experimental station for the study of problems of evolution, heredity and animal behavior, a "biological farm" as he preferred to call it, and although he was not successful himself in establishing such a station, others have since brought it about In the later years of his life Professor Whitman's personal researches became continually more engrossing and he gradually relinquished his other undertakings into the hands of younger men

Professor Whitman belonged to no narrow field of zoology His scientific interests were broad and they were continually bringing him into contact with workers in other fields He had a very deep interest in all the fundamental problems of biology and we thus find him forming close scientific association with workers in the fields of botany, physiology and psychology as well as in his own field of zoology.

In many respects the Marine Biological Laboratory constitutes Professor Whitman's chief monument Here his ideas had their fullest scope His fundamental idea in the conduct of the laboratory was cooperation, and he succeeded in establishing what has well been called a marine university, in which the ownership and control as well as the conduct of affairs is vested in the body of active scientific investigators The entire body of past and present investigators with few exceptions, constituting the corporation, is the court of last appeal, it elects the board of trustees mainly from its own membership, and the immediate control of laboratory affairs is carried out by the board through their appointive agents, the directors and members of the staff The result has been the realization in our own time and country of the ancient ideal of the university, a republic of scholars.

Such an organization is exposed to dangers internal and external, and though both kinds appeared at various times Professor Whitman always refused to compromise any fragment of his fundamental idea He was therefore often called an impractical idealist by men both within and without the organization Idealist he was, whether impractical or not was none of his concern He often seemed to be most resolute when he stood almost alone as when a safe harbor of refuge for the laboratory appeared within the protecting breakwaters of an established and endowed institution, and nearly all were ready to put into port Yet he preferred liberty and the storm, and all finally stood by him

Professor Whitman instantly recognized creative ability in an investigator, and his appreciation was invariably hearty, and his support ever ready to the fullest extent It is no accident that many of the important discoveries in biology in America during the last twenty years were made at Woods Hole Professor Whitman had early recognized the ability of the workers in question, and had invited them to work at Woods Hole and secured their allegiance to the laboratory, and to himself, for his was a most magnetic personality. Thus he gradually attached to the interests of the laboratory an increasingly strong body of scientific investigators.

Professor Whitman's interest in the teaching side of his profession is fully demonstrated by his organization of teaching as a department coordinate with research in the Marine Biological Laboratory. He steadfastly resisted the influence of some of the investigators in favor of doing away with instruction at the laboratory. He held that teaching exerted an important reflex influence on the body of investigators. He enjoyed and valued the presence of the student element, for whom he had constant sympathy and towards whom he exhibited the utmost friendliness. It has resulted at Woods Hole that the institution, which was made by investigators, has aided in the making of many investigators. Surely no environment more favorable for awakening and stimulating scholarly ambition could be found.

Although Professor Whitman published relatively few papers he nevertheless occupied a commanding position in science. Some of the reasons have already been indicated. His "eye was single and his whole body was therefore full of light", his devotion to scholarship was never open to the slightest shadow of suspicion. He was continuously engaged in his personal research which dealt with the most fundamental problems of biology, and he had accumulated vast stores of data, which we hoped he would live to publish himself. But apparently he could never satisfy himself with reference to the fundamental problems on which his mind was fixed, the grand consummation of his work had not come and he could not reconcile himself to the publication of more or less fragmentary pieces of work. His published papers, mostly short, are models of condensed thought, written in a fine, polished, characteristic style. No less care was devoted to the form than to the substance, and some of his papers certainly will endure as classics of the biology of his time. His activities in connection with the *Journal of Morphology* and the Marine Biological Laboratory brought him into close personal relations with the leading biologists of his time, most of whom learned to value highly his somewhat rarely and deliberately uttered expressions of opinion on scientific problems.

It was, therefore, not only his publications but also his work with his journal, his laboratory and his students, his constant helpful association with other workers and the example of his austere and studious life that brought him recognition. He never permitted himself to be distracted by the confusion of modern life, social or academic, nor diverted from his steadfast purpose by clamor for quick results.

It is impossible for us yet to measure justly the value of such a life to our community; it conveys a much-needed lesson of consecration to the ideals of scholarship, our appreciation of it will surely increase in proportion as time eliminates all the petty details that confuse the picture of a great man's life, and permits its essential nobility to shine forth undimmed.

F. R. L.

December 21, 1910

WITH the death of Charles Otis Whitman America has lost the third of her greatest scholars. Professor Whitman's name belongs with those of William James and Simon Newcomb, not only because of the profound influence he has exerted on the development of zoology in this country by means of his personality, by founding at Woods Hole a unique biological university and by the establishment of the *Journal of Morphology*, but also because of the strength of his character and the greatness of his achievements in science.

His scientific work marks him as a great master, for his finished, published papers are truly masterpieces both of content and expression. In addition to these he had accumulated by long, patient and untiring study an enormous mass of observations on the habits and behavior of pigeons, their phylogeny, inheritance, the origin of species and the progression of species by orthogenesis, independent of natural selection. The general results of this work he had presented from time to time in brief addresses and he was preparing for publication a full report of it, when he be-

came ill Among the results of his scientific work none is more fundamental than his proof of the real course of descent of the pigeons He showed that Darwin had been mistaken in believing the barred type of pigeon to be primitive The evolution was in reality from the checkered to the barred type This discovery led him to the evidence of orthogenetic development in the pigeons and filled in, provisionally at any rate, one of the most puzzling gaps left by Darwin in the problem of evolution. A correct understanding of the direction of evolution of the pigeons gave him, also, the key to the interpretation of the phenomena of inheritance, enabling him to escape the pitfalls which beset the steps of those who do not know the past history and direction of evolution of the forms with which they are working. In addition to this splendid and fundamental work there were, also, long years of study of the embryology and phylogeny of the leeches, the results of which were in part published in his papers on metamerism, the inadequacy of the cell theory of development, and embryology, but in large part remain unpublished, preserved in notes and exquisite drawings It is probable that much of this work and that on the pigeons will be found in such form that it can be published. As a scientist, Professor Whitman was painstaking, self-critical, patient and profound.

It is not, however, of his work as a scientist upon which I wish to dwell, but rather to recall his personality that the memory of it may remain always with us His white hair, his kindling, eager, but thoughtful eyes, his tender, gentle smile, his reticence of speech, his consideration for others, his generosity and courage; his hospitality and graciousness as a host, these endeared him to us all. We shall never forget his simple, unassuming, modest manner, his encouraging sympathy; his ripe and sane judgment. If when he was alone he lived simply, the absorbed student of science, when with his guests in his home he was the embodied spirit of hospitality

His great influence as a teacher was due in part to his fine example and noble ideals, and in part to his habit of picking out young men, who showed any love for science, inviting them to his home, drawing them out, encouraging them and giving them his friendship Many of them he helped financially, and all of those fortunate enough to work near him owe him a debt of gratitude for his sympathy and inspiration Probably no teacher in zoology since Louis Agassiz has exerted so great an influence on young men.

His uncompromising loyalty to principle and his high ideals of work and conduct were among his strongest characteristics. The Woods Hole Laboratory represented his ideal of a laboratory in its organization and spirit Again and again he stood almost alone against his most intimate friends and associates who, frightened at the financial outlook, wished to sacrifice those ideals He invariably prevailed in the long run and events have proved his judgment to have been sound He was a rock upon which all plans which were not shaped in accordance with ideals but rather in accord with opportunity, were sooner or later wrecked This loyalty to ideals was shown, also, in his struggle for a biological farm at the University of Chicago Having outlined an ideal biological farm he refused firmly to give up any feature of it which was essential to that ideal He preferred to wait until the ideal could be had, rather than to compromise on some less perfect scheme

He was always loyal, also, to his ideals of science and no amount of criticism or pressure could induce him to publish one word until he was sure that word was the truth and nothing more or less

He had also an uncompromising and outspoken hatred of shams and half-truths of all sorts. Unreliability in any particular he could never tolerate. He was slow to condemn any man, but once he had weighed him and found him wanting, he never afterwards trusted him. In common with many biologists he had no belief in a future life, but his own life demonstrated in the highest degree, how unnecessary such beliefs are to a truly noble soul.

If there was any one characteristic which

endeared him more than another to all in contact with him, it was his instinctive consideration for others and his warm sympathy. No matter how busy he was, he always welcomed one with a warm clasp of the hand and that charming, tender smile, no matter how long one stayed, it was always too soon to go, no matter how often one came, here was a friend who wished you to come more often. Those in trouble came to him. Every tie of affection, gratitude and respect bound us to him. Every meeting with him was a reinspiration in those splendid ideals of which his whole life was the expression.

We have lost a most loyal and affectionate friend, a great scientist and scholar, a truly noble and simple man.

Albert P. Mathews

SCIENTIFIC NOTES AND NEWS

At the Pittsburgh meeting, December 27–29, 1910, of the Geological Society of America the following officers were elected for the year 1911:

President—W. M. Davis, Cambridge, Mass.

First Vice-president—W. N. Rice, Middletown, Conn.

Second Vice-president—W. B. Scott, Princeton, N. J.

Secretary—Edmund Otis Hovey, New York City.

Treasurer—William Bullock Clark, Baltimore, Md.

Editor—Joseph Stanley Brown, Cold Spring Harbor, N. Y.

Librarian—H. P. Cushing, Cleveland, Ohio.

Councilors (1911–13)—Heinrich Ries, Ithaca, N. Y., and A. H. Purdue, Fayetteville, Ark.

At the recent Pittsburgh meeting of the American Paleontological Society, Professor William B. Scott, of Princeton University, was elected president. The statement in regard to the presidency, taken from the daily papers and printed in the last issue of Science, was incorrect. Other officers of the society are as follows: *First Vice-president*, Arthur Hollick, New York City; *Second Vice-president*, W. D. Matthew, New York City; *Third Vice-president*, Stuart Weller, Chicago, Ill.; *Secretary*, R. S. Bassler, Washington, D. C.; *Treasurer*, Richard S. Lull, New Haven, Conn.; *Editor*, Charles R. Eastman, Cambridge, Mass. Correspondents were elected as follows: Professor G. Alfred Nathorst, Stockholm; Professor E. Koken, Tubingen; S. S. Buckman, England, and Professor Charles Déperet, France.

Professor Ralph S. Tarr, of Cornell University, was chosen president of the Association of American Geographers at its recent meeting in Pittsburgh.

Professor L. B. Mendel, of Yale University, was elected president of the Society of Biological Chemists at the New Haven meeting.

At the annual election of the American Philosophical Society held on January 6 the following officers were chosen for the ensuing year: *President*, William W. Keen; *Vice-presidents*, William B. Scott, Albert A. Michelson, Edward C. Pickering; *Secretaries*, I. Minis Hays, Arthur W. Goodspeed, James W. Holland, Amos P. Brown; *Curators*, Charles L. Doolittle, William P. Wilson, Leslie W. Miller; *Treasurer*, Henry La Barre Jayne; *Councilors* (to serve for three years), Henry F. Osborn, Joseph G. Rosengarten, Edward W. Morley, Henry H. Donaldson.

A marble bust of President Emeritus Eliot, the work of Mr. Louis Parker, of New York, has been placed in the faculty room of Harvard University.

Dr. S. Weir Mitchell, who has been a trustee of the University of Pennsylvania since 1875, has resigned.

The Zoological Society of London has elected as corresponding members Mr. Theodore Roosevelt and Mr. W. H. Osgood, Mr. S. H. Scudder as foreign member.

Dr. H. C. Bumpus, director of the American Museum of Natural History, has been decorated by King Charles, of Roumania, with the grand cross of the commander of the order of the crown.

Sir T. Carlaw Martin, LL.D., editor of the *Dundee Advertiser*, has been appointed director of the Royal Scottish Museum, Edinburgh.

PROFESSOR ARTHUR H. BLANCHARD, of the department of civil engineering, Brown University, has recently been appointed expert and consulting engineer to the United States Office of Public Roads.

PROFESSOR M. V. O'SHEA, professor of education at the University of Wisconsin, has been appointed chairman of the American committee of the International Congress on Childhood and Youth. The next session of the congress will be held in the United States, probably at Washington in 1912.

ARTHUR R. CUSHNY, M.D., F.R.C.S., professor of pharmacology in the University of London, will deliver the first of the "Weir Mitchell Lectures" at the Weir Mitchell Hall in the College of Physicians, Philadelphia, on January 17. His subject will be "Heart Irregularity from Auricular Fibrillation."

DR. GUNTHER JACOBY, privatdocent at the University of Griefswald, and research fellow in philosophy at Harvard University, is giving a course of seven lectures on "Schopenhauer," beginning January 6. The lectures are open to members of Harvard University.

THE municipality of Dôle, Jura, has just voted to buy and preserve the house where Pasteur, on December 27, 1822, was born.

THE *Journal* of the American Medical Association states that as a permanent honor to its founder, who was also for many years its honorary president, the Verein fur innere Medizin und Kinderheilkunde of Berlin has resolved, on motion of Professor Schwalbe, to establish a Leyden lectureship, the lecture to be given annually at the first session of the winter semester, by a speaker selected by the board of directors. This arrangement, which follows the English custom, is the first of the kind made in Germany. A large fee will be paid the lecturer, derived from the interest of the fund of $14,000, established on the seventieth birthday of von Leyden. The rest of the interest on the fund is to be devoted to scientific research under the influence of the society for internal medicine.

THE death is announced at Cincinnati at the age of eighty-eight years of Mr. Benn Pittman, who with his brother, Sir Isaac Pittman, developed the system of stenography which bears their name, and is also known for his inventions in connection with electrotyping.

THE Sarah Berliner research fellowship for women will be awarded for the second time this year. This fellowship, of the value of twelve hundred dollars, is available for study and research in this country and in Europe. It is open to women holding the degree of doctor of philosophy, or to those similarly equipped for the work of further research; it will be awarded only to those who give promise of distinction in the subject to which they are devoting themselves. Applications must be in the hands of the chairman of the committee, Mrs. Christine Ladd Franklin, 527 Cathedral Parkway, New York, by February 1. This fellowship was awarded two years ago (it is given only every two years) to Miss Caroline McGill, Ph.D., who was a member of the teaching staff of the University of Missouri. Miss McGill has spent a year in Europe, chiefly at the Naples Zoological Station.

DR. A. D. GABAY, of New York City, has presented to the American Museum of Natural History a collection of ground and polished shells from California and Japan. These specimens with their convolutions and superb nacre make objects of great beauty. They will be installed in certain sections of the hall of mollusca, illustrating the economic and ornamental uses of shells. The museum has also received, as a gift from Mr. D. C. Staples, a collection of archeological and ethnological material which comes from the provinces of Esmeraldas and Manabi in the extreme northern part of Colombia, South America.

ACCORDING to *Nature* a new zoological garden in course of construction by Mr. Carl Hagenbeck in the grounds of the Villa Borghese, Rome, was expected to be opened on January 1. The grounds, which comprise twenty-eight acres, lie outside the old walls to the northward of the city, and it is stated

that more than $200,000 has been already spent on them, while the animals, some 1,400 in number, represent $50,000. As at Stellingen, cages have been to a great extent dispensed with, deep ditches and scarped cliffs serving to confine the animals, which thus appear to be at liberty.

CONSTRUCTION has begun upon the new Boston Psychopathic Hospital, which has been planned by the Board of Insanity, in accordance with an act of legislature, to receive, observe and treat the acute mental patients of the metropolitan district in Massachusetts. The hospital will be operated by the Boston State Hospital trustees, who have appointed Dr. E. E. Southard director. The institution is planned to contain one hundred beds and embodies the main features of the modern general hospital as well as special therapeutic features appropriate to mental disease. A wide scope is expected for the out-patient and social-service departments. Other districts in the state may in time develop similar psychopathic hospital units, which will take their place alongside the hospitals, asylums and colonies as special clearing-houses and therapeutic establishments for the acute cases of mental disease in each district. In the psychopathic hospitals emphasis will naturally be laid on investigations, both psychic and somatic, into the nature and causes of mental disease.

A BILL to make Paris official time coincide with Greenwich time was presented, as we learn from *Nature*, to the French senate on December 21. The bill was passed by the chamber of deputies several years ago, and has been approved by the senate committee and by the cabinet, so that in all probability it will become law. Paris time is 9m. 21s. ahead of Greenwich time, and upon the day prescribed by the law, the clocks indicating official time in France will be put back by that amount. By the adoption of the change, France will be brought into the international system of standard time reckoning which is now followed in the United States and in most civilized countries. On this system, the hour of each successive fifteen degrees of longitude, reckoning from the Greenwich meridian, is used for the standard time; hence the difference in time in passing from one zone to another is always an exact number of hours.

AT a meeting of the Paris Academy of Medicine held on December 13 the list of the prizes awarded during 1910 was read out by the secretary, M. Weiss. According to the *British Medical Journal* they include the following. The François-Joseph Audiffred prize ($4,800) was not awarded, but sums of $200 were granted to MM. Xavier Delore and André Chalier, of Lyons, for their work on tuberculosis of bone, by way of encouragement, in the same way a sum of $100 was given to M. Jules Lemaire, of Paris, for his researches on the skin reaction to tuberculin, especially in children. The Baillarger prize ($400) was awarded to Dr. Gabriel Doutrebente, of Tours, for his work on the medical organization of lunatic asylums. The Prix Barbier ($400) was divided between Dr. Maire, of Villejuif, for a memoir on the colonization of the epileptics of the Seine Department, and Dr. E. Sacquépée, of the Val-de-Grâce Military Hospital, for his notes on paratyphoid infection. The Boggio prize ($875) was awarded to Dr. Rappin, of Nantes, for his researches on a method of vaccination and immunization against tuberculosis. The Adrien Buisson prize ($2,000) was awarded to Drs. de Beurmann and Gougerot, of Paris, for their work on sporotrichosis; the Campbell-Dupierris prize ($450), to Dr. M. Jungano, of Naples, for a memoir on the flora of the urinary apparatus, normal and pathological; the Théodore Herpin prize ($600), to Dr. Félix Rose, of Paris, for a work on apraxia; the Huguier prize ($600), to Dr. Salva Mercadé, of Paris, for an essay on cysts and abscesses of the uterus; the Laborie prize ($1,000), to Dr. H. Dominici, of Paris, for his work on the treatment of malignant tumors with radium; the Louis prize ($600), to MM. P. Emile Weil, F. Lévy, and G. Boyé, for a paper on internal hæmostatic methods; the Meynot prize ($500), to Dr. Louis Balden-

weck, of Paris, for an anatomical and clinical study of the relations between the internal ear and the point of the petrous bone, the Gasserian ganglion, and the sixth pair of cranial nerves. The Orfila prize ($1,200), for the best essay on the purification of town water after use, and of polluted factory waters, was divided between MM Edmond Rolants, E. Boullanger, Léon Massol and Félix Constant. The Perron prize ($750) was divided between M. Albert Frouin, of Paris (on the possibility of keeping alive animals after complete removal of the thyroid apparatus, by the addition of calcium salts or magnesium to their food); M Gernaro Sisto, of Buenos Aires (the cry of sucklings and hereditary syphilis), and MM. Noel Fiessinger and Pierre Louis Marie, of Paris (notes relating to the protease and lipase of leucocytes) The Saintour prize ($875) was awarded to M Gabriel Petit, of Alfort, for a contribution to pathological anatomy and pathogeny of tumors of the breast; the Tarnier prize ($875) to M. Audré Delmer, for a contribution to the study of auto-intoxications of pregnant women and female bovine animals

THE statistics of coal production as collected jointly by the United States Geological Survey and the Bureau of the Census show that in 1909 the output amounted to 459,-209,078 short tons Compared with the record for 1908, when the production amounted to 415,842,698 short tons, the record for 1909 shows an increase of 44,039,650 short tons, or 10 per cent. All of the gain was in the production of bituminous coal, which increased from 332,573,944 short tons in 1908 to 378,-551,024 short tons in 1909—a gain of 45,977,-080 short tons. The production of anthracite in Pennsylvania decreased from 74,347,102 long tons (equivalent to 83,268,754 short tons) in 1908 to 72,015,222 long tons (equivalent to 80,658,049 short tons) in 1909. Pennsylvania made the largest increase in the production of bituminous coal, showing a gain of 20,666,288 short tons, from 117,179,527 short tons in 1908 to 137,845,815 tons in 1909. West Virginia for the second time in its history exceeded Illinois, and became the second state in the production of coal, the former having an output in 1909 of 51,446,010 short tons, and the latter an output of 50,970,364 short tons. West Virginia's production increased 9,548,167 short tons over 1908 The output in Illinois, which stood third in rank, increased only 3,310,674 Ohio retained its position as fourth in rank with a production in 1909 of 27,919,891 short tons, against 26,-270,639 in 1908 Indiana, which in 1908 supplanted Alabama as fifth in rank, strengthened its position in 1909 by an increase of 2,566,809 tons, from 12,314,890 tons in 1908 to 14,881,699 tons in 1909, while Alabama gained 2,099,317 tons, from 11,604,593 tons to 13,703,910 tons Other significant increases were in Colorado, 1,087,773 tons, Wyoming, 890,995 tons, Kansas, 734,270 tons; Montana, 640,082 tons, Iowa, 594,052 tons, and Washington, 551,463 tons Georgia, Idaho, Maryland, Michigan, Missouri and Texas showed a smaller production in 1909 than in 1908, the total decreases amounting to about 750,000 tons

Nature quotes from the *Aeronautical Journal* for October the announcement that the council of the Aeronautical Society had conferred the gold medal of the society on Mr. Octave Chanute, consulting engineer, of Chicago, shortly before his death Born in Paris in 1832, Chanute trained as an engineer in America, where his professional duties involved the construction of numerous railways and bridges, including consultative duties connected with the New York elevated railway, wood preservation was also his specialty From 1874 onwards Chanute became interested in the problem of aviation, and not only did he make numerous experiments with models, but shortly after, or perhaps simultaneously with, Lilienthal and Pilcher's experiments in Europe Chanute took up the practical realization of gliding flight in America in collaboration with Mr. Herring and Mr. Avery. A large number of glides were made with different types of glider, commencing with a model based on the descriptions of Le Bris's historic "Albatross," and including

gliders with a large number of superposed planes, but the type finally adopted was a biplane glider furnished with a smallish balancing tail Although balance was, as a rule, maintained by moving the body, Chanute embodied in his apparatus the principle of a flexible framework, which thus paved the way for the Wright Brothers' "warping" devices and similar arrangements for the recovery of balance and counteraction of instability, which form such a noteworthy feature of modern aeroplanes The glides made with his machines were remarkably successful, and, the practising grounds being among sand dunes, no fatalities ensued Chanute was the author of a number of papers and reviews dealing with the flight problem, and the Wright Brothers, the late Captain Ferber, and numerous other aviators were indebted to him for much valuable assistance

The following statement, concerning the University of Wisconsin, appeared in the republican party platform of that state

> We are proud of the high eminence attained by our state university We attribute its advancement both to the able and courageous guidance of its president and faculty and to the progressive and enlightened character of the citizenship that sustains it We commend its work, illustrated by what has been accomplished in agricultural and dairy affairs, conserving our natural resources which have effected a saving of millions of dollars annually to the people of our state We also commend its investigations for the improvement of the relations of men to one another We regard the university as the people's servant, carrying knowledge and assistance to the homes and farms and workshops, and inspiring the youth toward individual achievement and good citizenship. We recognize that its service to the state, through investigations in agriculture, industrial and social institutions, depends upon its freedom to find the truth and make it known, and we pledge the republican party to the policy of academic freedom so well expressed by the board of regents in 1894, when they declared "Whatever may be the limitations which trammel inquiry elsewhere, we believe that the great State University of Wisconsin should ever encourage that continual and fearless sifting and winnowing by which alone the truth can be found."

UNIVERSITY AND EDUCATIONAL NEWS

An alumnus, who does not wish his name disclosed, has given $100,000 to the University of Pennsylvania for the endowment of a chair of physiological chemistry. It will be known as the "Benjamin Rush chair of physiological chemistry" Dr Alonzo E Taylor, formerly of the University of California, will be the first occupant of the chair

The University of Vermont has received $67,965 from the Rockefeller Foundation, representing the first instalment of a gift of $100,000 made to the university on condition that an additional $400,000 be raised. The $400,000 has now been subscribed and the amount $271,000 has been collected The half million dollars is to be added to the endowment fund for the general uses of the university

Mr William Blodgett has given to Columbia University two farms near Fishkill, N. Y., to be used in connection with the work in agriculture.

The mining engineering building of the University of North Dakota is being enlarged and the interior remodeled in response to an imperative demand for more room. The roof has been raised, materially adding to the light, floor space and utility of the technical museum Adjoining the museum, which is in the center of the building, there is to be at one end a large preparation room for the curator and at the other a mineral stock room. The laboratories on the first and second floors have been readjusted to provide better facilities for the classes in analytical chemistry and metallurgy as well as for research work in ore treatment, coals and clays. The newly-established ceramic department is being equipped with general clay working and pottery machinery.

Columbia University, according to the official catalogue which has just been published, has this year a registration of 7,429 students. The vast majority of these are in the graduate and professional faculties, the undergraduate and scientific departments having a total registration of 1,456. Nearly every department of the university shows an increase of

from 5 to 20 per cent The academic department has 732 students as compared with 636 a year ago. The medical school, which for the first time required more than a high-school training for admission, has practically the same number of students as it had a year ago, 316 men fulfilling the requirement of two years' college work having entered the school The number of officers and instructors is the largest in the history of the university, numbering 761, including the emeritus professors, of whom there are 16 The newly-appointed professors include William B Fite and Herbert E Hawks, in the department of mathematics, Walter Irvine Slichter, electrical engineering, George V Wendell, physics, and Milton C Whitaker, industrial chemistry

DR EDGAR F SMITH, professor of chemistry in the University of Pennsylvania, became provost on New Year's Day, succeeding Dr Charles C Harrison, who had held this office for seventeen years Dr Smith will continue to lecture on chemistry

PROFESSOR G R THOMPSON, professor of mining, University of Leeds, has been appointed professor of mining at the South African School of Mines and Technology, Johannesburg, and principal of the college

PROFESSOR GUIGNARD, who has served for fifteen years as director of the Paris School of Pharmacy, has resigned his appointment and is succeeded by Mr Henry Gautier, professor of mineral chemistry at the school

THE professors of the Paris medical college have nominated Dr Dejerine, professor of medical pathology, to the clinical chair of diseases of the nervous system at the Salpêtrière. This position, once held by Charcot, was recently occupied by Professor Raymond, who died last September.

DISCUSSION AND CORRESPONDENCE

INORGANIC NOMENCLATURE

IN the issue of SCIENCE for December 9 appeared an article on the nomenclature of the acid phosphates The author, R E B McKenney, pointed out the difficulty of identifying these from the trade names, and suggested more exact names as primary, secondary and tertiary or, better, mono-, di- and tri-potassium phosphates While the change would be a step in the right direction it fails with salts of the polyvalent metals; for the mono-calcium salt would correspond to the di-potassium and thus the confusion would be perpetuated It appears to the writer that a more scientific method would be to indicate the number of replaceable hydrogen atoms (per molecule of acid) present in the salt Thus K_2HPO_4 and $CaHPO_4$ would be named mono-hydrogen phosphates while KH_2PO_4 and $CaH_4(PO_4)_2$ would be the di-hydrogen phosphates The normal phosphates could then be designated as such or simply as phosphates

In this connection I would call the attention of chemists, manufacturers and printers of chemical names to the need of a thorough revision of inorganic nomenclature It is still common to hear and read the names potassic hydrate for potassium hydroxide and sodic carbon for sodium carbonate, the hydrogen (acid) carbonates are called bicarbonates because in making them two equivalents of the acid are required for each equivalent of the base But modern chemistry is founded on molecular rather than equivalent quantities and a bicarbonate should mean, therefore, two carbonate (CO_3) radicals in the molecule of the salt Besides, the bichromates are not acid salts at all in the sense of containing replaceable hydrogen atoms Likewise the percarbonates, persulphates and permanganates do not follow the nomenclature of the perchlorates, perbromates and periodates Also the dioxides and peroxides are named with no discrimination as to differences in constitution.

Has not the time come for scientific men to be exact and scientific in the matter of chemical nomenclature, and to demand of manufacturers the use of names which shall indicate the composition of the material designated? And would it not be well for section C of the American Association, or the American Chemical Society, to appoint a permanent committee on inorganic nomenclature to

the end that all chemical names shall be understood, because they indicate exact composition?

J. H. Ransom
Purdue University,
Lafayette, Ind

COASTAL SUBSIDENCE IN MASSACHUSETTS

To the Editor of Science: While Professor D W Johnson has clearly shown in the November 18 issue of Science that there are certain factors which produce fictitious appearances of coastal subsidence, chief of which is the irregular height of the tidal wave due to the varying character of the shore, there are a number of marks of subsidence on the Massachusetts coast which it is not probable can be so explained For example, near Misery Island, Beverly, stumps of forest trees appear in place at a depth of twelve to fourteen feet below low tide

The striking example given by Professor Johnson of the fictitious appearance of coastal subsidence at Scituate proves also, it seems to me, that subsidence has really been going on The very fact that the level of the inside marsh was several feet below the outside level of high tide showed how much the land had sunk since the mouth of the North River had been nearly closed A very similar state of affairs exists in the region of the Norfolk Broads in the eastern part of England Here, in the same way, the land is slowly sinking, but, owing to the silting up of the mouths of the Yare and the Bure rivers, aided by dyking, the tides have been largely excluded, the marsh has become fresh and has so long ceased to build up that it is below the level of high water outside, and there is danger of the sea breaking through the sand dunes and, as at Scituate, drowning out the region.

Charles W. Townsend
Boston,
December 2, 1910

CALENDAR REFORM

To the Editor of Science: I read with interest Professor Chamberlin's suggestions for the reform of the calendar, in the current number of Science, November 25. It happens that I had thought of a scheme the same as that of Professor Chamberlin in all essential features, but was led to abandon it before publication because I considered that its disadvantages outweighed the advantages.

The advantages of the seasonal division are very slight The scheme would suit conditions here as well as the present arrangement. In Great Britain, however, the winter begins in November, spring in February, etc. Hence Professor Chamberlin's arrangement with winter beginning in January would not suit conditions and would not be accepted. The earth receives the smallest amount of heat and light at the winter solstice, and neglecting lag this should be midwinter. To call it the beginning of winter as astronomers do, is to allow 45 days lag To call January 1 the beginning seems to be allowing 55 days lag, not 10 as stated by Professor Chamberlin This lag varies so much in length with latitude and local conditions that it does not appear that any division of the months into seasons will be universally satisfactory

The desirability of a year divisible into quarters is unquestioned. But let us see the disadvantages of the scheme. A man who pays rent, for instance, would find his rent due in the first quarter on the first of the month, say. It would be due the Monday of Easter week, on the twenty-second of the month in the second quarter, fifteenth in the third and the eighth in the fourth. Likewise with monthly salaries and, in fact, all business done by the month. A promissory note dated February 15 due in two months would be due April 8, but if due in one month, March 15, or if due in nine months it would be due October 22. If due in eight months, on the first day of Gregorian week. Likewise, in finding the interval in days between two days we should always need to be on guard against omitting or including wrongly one of these weeks. This problem is a very common one in business. Since the suggestion has been made, there will be no difficulty in multiplying these illustrations indefinitely. When we compare this complexity with the simplicity of the same problems in the regular 13 months of 28

days we see how much is lost. These same objections of course apply, but with less force, to the scheme of Reiminghaus, July 29.

Professor Chamberlin's plan would cause the month to be abandoned as a unit of time for business, and force us to use the week or day

It is true that the same objections may be raised to the 13-month system if we use a quarter as a unit, that is, a quarter from February 15 would be May 22, two quarters, August 1 (assuming the extra month in the middle of the year) But withal this is simpler Moreover, when we compare the amount of business done by the quarter with that done by the month and day we see which should have the greater consideration in constructing a simple calendar

I feel sure that these objections could not have occurred to Professor Chamberlin

SAMUEL G BARTON

CLARKSON SCHOOL OF TECHNOLOGY,
November 29, 1910

INTERNATIONAL CONGRESSES

TO THE EDITOR OF SCIENCE: At the request of the Swedish geologists the International Geological Congress took place this year instead of 1909 This year was also that in which the International Zoological Congress naturally fell to be held. Since, for the convenience of university workers, these congresses are usually held at the same time of year, and since they, with their excursions, now extend over a considerable period, especially in the case of the Geological Congress, it was almost inevitable that the times of the meetings should clash. This may not affect a large number of participants, but it is rather hard on paleontologists, whose interests lie in both camps, and who, even with the aid of the aeroplane, can not be in two places at once. I should not trouble you with a complaint about what appeared to be inevitable this year, were there not signs of the same difficulty recurring in perpetuity, unless a protest is at once raised. As a matter of fact, the committee of "Paleontologia Universalis," when it met at Stockholm, forwarded to the council of the congress a request that this interference should be avoided in future. That protest seems to have been without result. If so, in 1913 the paleontologist will again find himself summoned either by duty or desire to opposite quarters of the globe

F. A. BATHER

SCIENTIFIC BOOKS

Monograph of the Okapi. By SIR E RAY LANKESTER, K.C B, M A., D.Sc, F.R S, etc Atlas (of 48 plates) London, printed by order of the Trustees of the British Museum 1910. 4to, pp i–viii, plates 1–48

Few events of recent years have aroused the interest of naturalists so much as the discovery of the okapi. It was sufficiently surprising that so large and strikingly marked an animal should have remained undiscovered for so many years, that it should prove to be related to a group now extinct increased the interest in the okapi and the known facts relating to it were promptly given in papers of scientific or popular interest, and more comprehensive memoirs were planned by those fortunate enough to be in the way of securing material Among them was the present monograph, commenced by E Ray Lankester while he was director of the British Museum and which having been delayed by many causes is a monograph in name only It consists of 48 plates without text and it is stated in the preface that it is doubtful if the accompanying text will be issued, the need for any having been lessened by the appearance of Fraipont's monograph in 1907, and de Rothschilds and Neuville's paper during the present year, 1910 Fraipont's memoir, by the way, was begun by Forsyth Major, whose interest seems to have flagged after having had a number of illustrations prepared. The plates in Lankester's monograph comprise dorsal, lateral and palatal views of various skulls, drawn on a liberal scale, one third to one half natural size, and these are sufficient to afford good terms of comparison with other material. There are also views of the entire animal including one of a living calf, and plates illustrating variations in the vertebræ. As the explanations of the plates are very full a

pretty clear idea may be obtained of the character of the okapi itself, the great lack being detailed comparison of the okapi with other ungulates, living and extinct, and consequently, the absence of information regarding the relationships of the animal A large number of illustrations are devoted to variations in the striping of the fore and hind legs, practically no two animals being alike in this particular Some of these figures are from mounted specimens, and some from bandoliers made of okapi skin, including the first two obtained by Sir Harry Johnston, which Dr. Sclater took to be from a zebra and in this belief described the animal as *Equus johnstoni*, on February 5, 1901, the generic name *Okapia* being given by Lankester later in the same year *Okapia liebrechtsi* was described by Forsyth Major in 1902 and subsequently Lankester based a third species, *O erichsoni*, on a peculiarity shown in the frontal hair whorls of an individual There is, however, little doubt that there is but a single valid species

It was a theory of Professor Marsh that good illustrations were really more important than text, since they showed facts that might be used by any one while the text would consist naturally more or less of the opinions of the writer From this viewpoint the volume under consideration will be appreciated by all It is also valuable as a study in individual variation, no two specimens of the okapi being quite alike either in external appearance or internal structure And while Lankester qualifies his remarks on these points by saying that he has not had the opportunity of examining a similar amount of material of any other species of large wild animal there can be little doubt but what the okapi is really exceptional in the amount of individual variation it presents

F A. LUCAS

Reproduction artificielle de minéraux au XIXe siècle By P N. TCHIRWINSKY Kief, 1903–1906 8vo Pp. lxxxviii + 638, 117 figures and 11 portraits

A very comprehensive work on the artificial production of minerals has recently been published in Russia by Professor Tchirwinsky The work contains 177 figures of various crystals, some fifty of which were produced by the author himself, and also eleven portraits of scientists who have worked on synthetical minerals

While covering the same ground as the earlier treatises on the subject by Fuchs (1872), Fouqué and Michel Lévy (1882), Bourgeois (1882) and Meunier (1884), as well as the chapters devoted to this subject in the works on mineralogy by Doelter (1890) and Brauns (1896), the writer has not only added a very complete record of the rich and important results of scientific research in this department during the last two decades of the past century, but has revised and rearranged the earlier material, and corrected several errors in the references The critical remarks with which he accompanies his résumés are to a considerable extent based upon his own experiments

The work falls into two parts, a general and a special part At the outset the writer explains that he uses the term "artificially produced minerals" only in regard to those which are produced in the laboratory, and not in reference to such as may be fortuitously produced, as for example, the diamonds which have been found in steel, or minerals formed upon metal ornaments, etc., that have been long buried (pp 13–15) In this connection the author cites the words of St Meunier, that the convalescent who two thousand years ago cast a coin into a mineral spring whose waters had cured him, little knew that he was initiating a geological experiment[1]

The writer then proceeds to describe the more important kinds of apparatus employed in the laboratories for the artificial production of minerals, many of these are figured (pp. 15–24). He next passes to the consideration of the methods used for measuring artificial crystals (pp. 25–27) The fact that in a large number of cases these crystals are exceedingly small and can only be viewed through the

[1] Page 14, note St Meunier, "Méthodes de synthèse en minéralogie," Paris, 1891, p 55

microscope, makes it very difficult to measure them accurately and to determine their exact form As the study of artificially produced minerals would be greatly facilitated by having an approximately complete collection in one place, the author expresses the wish that specimens of such minerals produced in various countries might be sent to the Société Minéralogique de France, in Paris; these, added to the large number of such minerals now in the Collége de France, etc, would make an exceptionally complete collection An atlas of colored plates figuring the most important of them might then be issued by the French society, and this would serve to supply the lack of such material in many collections (pp 27, 28)

The aims of mineral synthesis are then presented at some length (pp 28-124) The light thus thrown upon the question of the natural formation of minerals is noted in the case of metalliferous deposits (pp 30-33), dolomites (pp 33-37), contact minerals (pp 37-40), the formation of the diamond (pp 43, 44), etc This is followed by sections treating of the physical and chemical conditions influencing the form of crystallization assumed by various minerals and the order of their production, and also of their systematic classification, as explained or furthered by the results attained in artificial reproduction (pp 49-119). It would be impossible, within the limits of this article, to do more than note the convincing demonstration of the great service rendered by the synthetic method in the solution of many difficult problems Several mineral forms have been produced in this way in a purer state than that in which they naturally occur, in some instances forms not yet discovered have been produced, thus serving to fill up gaps in the different classes. In other cases where it is difficult or impossible to make an accurate analysis of the natural specimens, the synthetic products have supplied this deficiency, as in the case of the chalcomenit from Argentina which was reproduced by C Fridel and E. Sarradin in 1881 (p 104) A very full list of the spinel crystals obtained by E. Ebelman is given (pp. 78-81)

While the scientific value of these artificially produced minerals can scarcely be overestimated, their practical value is very slight (p 120) As the author notes, only the ruby has been reproduced in a form and size that renders the specimens to a great extent the same as the natural stones, and yet even in this case—apart from the fact that they are not products of nature, but of art—a careful examination reveals certain peculiarities, due to the method of production, which differentiate them from the natural rubies

In the special part of the work (pp 127-496) the very rich and complete material has been arranged in approximately chronological order, all the minerals produced by a given experimenter being grouped together under his name This arrangement has its advantages, although it obliges the reader to seek in different parts of the book for information regarding any one mineral This search is, however, facilitated by very complete indexes A supplement (pp 497-638) contains material omitted for one reason or another from the main work, here the arrangement is according to mineralogical classification

Tchirwinsky has never been sympathetic with Moissan at any time or in this work. He has said, for excellent reasons

The volume contains nine excellent portraits, the list of which is here added

Eilhard Mitscherlich Professor of chemistry in the Berlin University, member of the Berlin Academy of Sciences, d 1863

Henri Sainte Claire Deville Professor of chemistry in the École Normale and in the Sorbonne, member of the Académie des Sciences, d. 1881

L Troost Professor of chemistry in the Sorbonne, member of the Académie des Sciences.

F A Fouqué Professor of the natural history of inorganic bodies in the Collége de France, member of the Académie des Sciences Paris

A. Michel Lévy Member of the institut, general inspector of mines Paris

Charles Friedel. Professor of mineralogy and of organic chemistry, d 1900 Paris.

Etienne Stanislas Meunier Doctor of Sciences, laureate of the institut Paris

Constantine Demetrius Chroustchoff. Professor of mineralogy, crystallography and petrography in the St Petersburg Academy of Medicine St. Petersburg

A B Fr af Schultén Professor of chemistry in the Alexander University at Helsingfors

SCIENTIFIC JOURNALS AND ARTICLES

The December number (volume 17, number 3) of the *Bulletin of the American Mathematical Society* contains the following articles: Report of the September meeting of the San Francisco Section by C. A Noble, "A new proof of the theorem of Weierstrass concerning the factorization of a power series," by W D MacMillan, Review of Kowalewski's Determinantentheorie, by Maxime Bôcher, Review of Wright's Invariants of Quadratic Differential Forms, by L. P. Eisenhart, Review of Volume 4 of Sturm's Geometrische Verwandtschaften, by Virgil Snyder, "Notes", "New Publications"

The January number of the *Bulletin* contains Report of the October meeting of the Society, by F N Cole, Report of the Konigsberg meeting of the Deutsche Mathematiker-Vereinigung, "On the saddlepoint in the theory of maxima and minima and in the calculus of variations," by R G D. Richardson; "Note on identities connecting certain integrals," by Louis Ingold, Review of Poincaré's Gottingen Lectures, by G D Birkhoff, Review of Lorentz's Theory of Electrons and of Wien's Elektronen, by E. B Wilson, "Shorter notices": Lilienthal's Differentialgeometrie, Volume 1, by E J Wilczynski, Boehm's Elliptische Funktionen, Part 1, by L. W Dowling, Dingeldey's Sammlung von Aufgaben zur Anwendung der Differential- und Integralrechnung, by E W Ponzer, Murray's Calculus, by W R. Carver, Crabtree's Theory of Spinning Tops and Gyroscopic Motion, by E W Brown, Loney's Dynamics of a Particle and of Rigid Bodies, by W. R Longley, "Notes", "New Publications"

The *Journal of Experimental Medicine* begins its thirteenth volume with the announcement that it will hereafter be issued once a month instead of once in two months as heretofore. Two volumes will thus be issued each year. No change is made in the price of subscription. Dr. Benjamin T. Terry takes the place of Dr Eugene L. Opie as the associate of Dr. Simon Flexner in the editorial control of the journal.

SPECIAL ARTICLES

VISUAL SENSATIONS FROM THE ALTERNATING MAGNETIC FIELD[1]

The experiments reported by S. P. Thompson in the *Proceedings of the Royal Society*, B, 82 (557), pp 396 ff., are of great importance, especially in view of the negative results which have been obtained in the several earlier attempts to arouse sensations by subjecting the head to the influence of a magnetic field Previous experimenters seem, however, to have used direct current, while Thompson used alternating current

Thompson obtained his magnetic field from a coil of 32 turns of stranded copper conductor of 2 square inch equivalent cross section, the coil having an internal diameter of nine inches and a length of eight inches. This coil was supplied with 50-cycle alternating current, the maximal amperage being 180 The subject's head was inserted in the coil, and under these conditions Thompson and several others were able to obtain flickering light sensations which were especially conspicuous in the peripheral part of the visual field The flicker was noticed even when the eyes were open Certain subjects reported sensations of taste also

It occurred to me on reading Thompson's report that the visual phenomenon might well be due to idio-retinal light, under the suggestion of the hum of the coil due to the alternating current, and as Thompson mentions no specific checks or precautions in his procedure, it seemed worth while to repeat the ex-

[1] I am indebted to the persons mentioned in this paper for their interest and participation in the experiments, and especially to Professor J. B. Whitehead and Mr Henry C. Louis, without whose cooperation the experiments would have been impossible.

periment. Professor Whitehead readily agreed to cooperate with me, and the first tests were made in his laboratory and under his personal supervision.

The coil used had 27 turns of a cable consisting of 37 copper wires (each 082 inch in diameter) equivalent to 250,000 circular mils. The coil was approximately 8 inches long, and elliptical in cross section, the internal diameters being 10.5 inches and 9 inches. With this coil no part of the subject's head or face touched the internal surface, a condition which we could not always attain with a coil of circular cross section and 9 inches internal diameter, which we first tried The coil was suspended from the ceiling by ropes, so that the subject could sit in a chair with his head inside the coil. The transformer available forced approximately 200 amperes of 60-cycle A C through the coil, the potential drop between coil terminals being slightly over 12 volts. This gave a field of 5,400 ampere turns, against 5,760 maximal in Thompson's experiment.

On first trial I distinctly perceived the flicker Dr Anderson, Dr. Cowles, Dr Essick and a student also perceived it on first trial Dr Watson was uncertain on first trial, but on second trial perceived the flicker, although not very distinctly until after several trials Dr. Jennings, Dr Whitehead and several others perceived absolutely nothing, even after careful trials. It still seemed to me possible that idio-retinal light and suggestion were at the bottom of the phenomenon and therefore Dr. Watson and I carried out some careful tests in which suggestion was excluded to the fullest possible extent, which tests showed conclusively that my suspicion was unfounded. In these tests the transformer rested on a table close beside the coil, so that the loud noise of the former completely drowned the hum of the latter The current could be switched off the coil, and on resistance carrying practically the same amperage as the coil, so that in either case the transformer noise was the same A telephone receiver connected with the transformer was hung on the coil, emitting a loud noise whether the current was on the coil or on the resistance. For further precaution the subject's ears were plugged up as well as was possible Under these conditions, where there was absolutely no way of telling by the sound whether the current was on or off the coil, each of us was able to identify the flicker with absolute precision

Several subjects noticed a twitching of the eyelids, when the head was in the coil. This was noticed especially by two of the subjects who were unable to perceive the flicker, and who thought it probable that the muscular sensations were at the base of the phenomenon. They were asked to report on the twitching, while the current was being turned now on the coil, now on the resistance, and it was found that the twitching occurred just as strongly when there was no current on the coil as when there was current

Those who perceived the flicker found it becoming less distinct after a minute or even less of stimulation, and found it restored by a few minutes' rest

The flicker was best perceived with the eyes closed or with the room darkened, but was noticeable with the eyes open if the room was not too brightly lighted. The interior of the coil furnished a fairly dark background

I made tests with both positive and negative after-images but could not find that the flicker affected them in any way The flicker was strongest in the peripheral visual field, and possibly did not affect to any considerable degree the central portion of the field, in which were the after-images

It was clear, as a result of these tests, that the phenomenon was really a matter of visual sensation, and that we were dealing with threshold values, it needed only higher intensity to make the flicker visible to all subjects Further it seemed to me strongly indicated that current of less frequency would give more intense flicker. Mr. A. E Loizeau, of the Consolidated Gas, Electric Light and Power Company, kindly offered us the facilities of his testing plant, and the coil was accordingly removed thither, and further tests

carried out under the supervision of Mr. Henry O. Louis of the company's electrical engineering department.

We forced 440 amperes of 60 cycle alternating current through the coil, with terminal potential drop of 32 volts. The flicker now became much more distinct than it had been at the lower amperage. Dr. Whitehead, Dr. Jennings and one of the students who before had not noticed any flicker, were present at these tests and now got the flicker very clearly at first trial. Mr. Louis and a number of the electricians also testified to the unmistakable nature of the phenomenon.

With 480 amperes of 25-cycle current (20 volts) a much more striking result was obtained. With my head below the level of the coil, and with my eyes open, the flicker was strongly noticeable, although the room was brightly lighted by afternoon daylight. The whole visual field quivered as if illuminated by a rapidly intermittent light. Several other subjects made a similar observation, although in some cases the flicker was noticed only in the less illuminated parts of the visual field, as where shadows fell in the room. With the head inside the coil the flicker was so pronounced as to be intensely disagreeable. The flicker seemed to me slower than with the 60-cycle current, and Mr. Louis and one of his assistants found the same apparent difference. Others were uncertain as to this point. The flicker with 60-cycle current had seemed to me to differ in character from ordinary visual flicker; it was odd, or novel in an indefinite way, but the flicker with 25-cycle current seemed quite like ordinary rapid flicker. This difference I am inclined to explain by the fact that normally a flicker of 60 per second is imperceptible, hence such a flicker seems unusual when produced under these abnormal conditions.

With the 200-ampere current, I had found that with the head either above or below the coil, with the face turned either upward or downward, practically no effect was obtained, although in two of these positions the eyes were close to the plane of the end of the coil, and hence in a strong magnetic field. Rotation of the head from one of these positions through 90° (presenting the side of the head to the coil) brought in the flicker distinctly. My observation on this point was confirmed by Dr. Anderson and Dr. Watson. With the stronger currents the effect was much more pronounced. Although some flicker was observed when the occipito-frontal axis was vertical, rotation of the head through 90° caused a great increase. This would suggest that the effect is due to induction currents in the optic pathway, since in the position with occipito-frontal axis vertical, the general direction of the optic pathway is parallel to the lines of force, whereas rotation of the head through ninety degrees brings the pathway across the lines. When the head is inside the coil, the pathway crosses the lines in the most intense part of the magnetic field.

Whether currents induced in the optic pathway excite the occipital cortex directly, or excite the retina primarily, is yet a matter for conjecture. That flicker is produced by alternations faster than the fastest flicker from normal light stimulation is of course no evidence for the non-retinal character of the flicker in question.

I can not say as yet that there is a definite *arousal* of visual sensation by the alternating field; the effect appears more like an alternate intensification and inhibition of whatever sensory process is already in progress. That is to say, if a certain intensity of normal light-sensation or idio-retinal light is present before the current is turned on, the apparent effect of setting up the alternating field is alternately to increase and decrease the intensity of the sensation so that the average intensity is not changed. It is quite possible that further observation will change my opinion on this point.

No sensations other than the visual, which could be connected with the alternating field were noticed by any of us. That there is no after-effect from the stronger fields, I should not like to say at present. I should advise any experimenter to proceed cautiously.

It is very desirable that experiments with a

large range of amperages and frequencies be made, but I am not certain that I shall be able to carry these out in the near future The difficulties in the way of securing adequate control of current when high amperages are used are greater than may appear to the casual reader

KNIGHT DUNLAP

JOHNS HOPKINS UNIVERSITY,
December 20, 1910

THE GERM CELL DETERMINANTS IN THE EGGS OF CHRYSOMELID BEETLES

PARTS of my papers on "The Origin and Early History of the Germ Cells in Some Chrysomelid Beetles,"[1] and "The Effects of Removing the Germ Cell Determinants from the Eggs of Some Chrysomelid Beetles"[2] have recently been subjected to criticism,[3] which, it seems to me, needs some analysis I have shown in these papers that a disc-shaped mass of darkly staining granules appears at the posterior end of the eggs of certain chrysomelid beetles just before deposition Because of the shape of this mass and its position in the egg, I have called it the "pole disc" During the formation of the blastoderm, those cleavage products which, in their progress toward the periphery, encounter the pole disc granules, gather these about themselves and continue their migration, finally becoming entirely separated from the egg They then lie in a compact group at the posterior end These are the primordial germ cells, they can be traced back into the embryo, where they separate into two groups which become the germ glands The conclusion was reached that the cleavage products "are potentially alike until in their migration toward the periphery they reach the 'keimhautblastem.' Then those which chance to encounter the granules of the pole disc are differentiated by their environment, *i e*, the granules, into germ cells; all the other cleavage products become somatic cells" (1908, p. 21).

It was found to be possible to remove the pole disc from freshly laid eggs by pricking the posterior end with a needle and allowing them to flow out Eggs operated upon in this way produced embryos and larvæ either without germ cells or with only a few This experimental evidence, added to that derived from the morphological study, seemed to prove that the pole disc granules were necessary for the production of the primordial germ cells and, in fact, determined them as such This led to the conclusion that the "granules of the pole disc are therefore either the germ cell determinants or the visible sign of the germ cell determinants" (1908, p 21) Recent experiments give additional evidence When the posterior ends of freshly laid eggs are killed with a hot needle, thus preventing the pole disc from taking part in development, no germ cells are produced in the embryos and larvæ which develop from them

Wieman objects to the term "germ cell determinant" since "the term implies the attribute of certain potentialities that these granules have not been shown to possess" (1910, p 180) He also objects to my hypothesis that the pole disc granules consist of chromatic material extruded by the nucleus of the oogonium, and claims that "the granules of the pole disc consist of particles derived from the food stream of the ovum that form an accumulation of the protoplasm in its posterior part" (1910, p 187) This is no doubt correct I did not attempt to discover the origin of these granules, but concluded that they were of nuclear material because of the derivation of similar substances in the early development of *Ascaris, Cyclops* and a number of insects. According to Wieman, "the granules are not all taken up by the cells in their migration and the greater part of them remains behind after the cells have passed through" (p. 186). This is certainly not the case in the four species of beetles that I have used in my work.

Wieman suggests several possibilities as to the ultimate origin and significance of the pole disc granules These possibilities were

[1] *Journ Morph*, Vol 20, 1909, pp. 231–296.

[2] *Biol Bull*, Vol 16, 1908, pp. 19–26

[3] Wieman, H. L, "The Pole Disc of Chrysomelid Eggs," *Biol. Bull.*, Vol 18, 1910, pp. 180–187

fully considered in my papers as the following quotations will show. Wieman says (p. 186), "The granules may therefore be of the nature of chromatin and actually represent the chromatin of the nurse cells . . " In my paper (1909, p. 274) is this statement, "the granules of the pole disc may be derived from the nuclei of the nurse cells which, in many insects, pass into the early oocytes" Again Wieman remarks (p. 186) "The fact that the pole disc occupies a position between the pole cells and the yolk gives a considerable foundation for regarding it as a source of nutrition for these cells" My suggestion reads as follows (1909, p. 275) "they may hasten the growth at the posterior pole of the egg, and that later they may possibly increase the vigor of the pole cells That the pole cells need special means of nourishment is doubtless the case, for, contrary to the condition in the blastoderm cells, they are at an early period entirely separated from the yolk, and later use up energy in their migration"

Furthermore, Wieman unconsciously admits that the pole disc granules are really germ cell determinants in the following words (p. 186). "If then the pole disc represents a part of the nutritive stream of the ovum that has not been transformed into ordinary yolk, but instead has been reserved to supply the pole cells, the conclusion presents itself that the latter as a result of this special kind of nutrition, undergo a peculiar method of metabolism which differentiates them from the somatic cells"

An account of the significance of the germ cell determinants in chrysomelid beetles and other animals is now in press.[4]

R. W HEGNER

UNIVERSITY OF MICHIGAN,
December 21, 1910

[4] *American Naturalist.*

THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE THE MINNEAPOLIS MEETING

REPORT OF THE GENERAL SECRETARY

THE sixty-second meeting of the American Association for the Advancement of Science was held at the University of Minnesota, Minneapolis, December 27 to 31, 1910. The registered number of members in attendance was approximately 500, but the actual attendance was probably not far from 1,200. Both in registration and attendance the meeting was an advance upon those of St Louis and New Orleans It also furnished an illuminating answer to the question whether a successful and well-attended meeting can be held in the middle west

All meetings of the sections and affiliated societies were held on the campus of the university, with the exception of the Thursday sessions of the botanists and the entomologists, which were held at the college of agriculture. Three public addresses were held. On Tuesday evening, the retiring president, Dr David Starr Jordan, gave his address, "The Making of a Darwin," in Minneapolis On Thursday evening, Mr W. A. Bryan gave an illustrated public lecture on the Hawaiian volcano Kilauea On Wednesday evening in St Paul, Mr A. B Stickney delivered a public lecture on the subject, "Should Practical Agriculture and the Physical Development of Childhood be Added to the Curriculum of the Public Schools." Of general interest also was the symposium on aviation under the auspices of Section D on Friday, and the unusually well-attended dinner and convention of Sigma Xi on the afternoon of the same day

Section A and the Chicago Section of the American Mathematical Society met for the most part in joint session, with a total of 34 papers. On Friday afternoon they considered the report of the Committee on the Teaching of Mathematics to Students of Engineering. Section B and the American Physical Society met constantly in joint sessions, at which 33 papers were presented. In addition, a general interest session in charge of Section B was held on Thursday morning, while in the afternoon, B and D met jointly for the reading of the vice-presidential addresses.

In accordance with the present plan, Section C held no meetings apart from a session for the delivery of the vice-presidential address. All sessions of the general program

were essentially joint sessions, though under the auspices of the American Chemical Society. Two addresses and 8 papers were presented at the general meetings. Sixteen papers were read before the Division of Agricultural and Food Chemistry, 12 before the Division of Fertilizer Chemistry, 4 before the Division of Pharmaceutical Chemistry, and 8 before the Chemical Education Section. The largest number of papers, 47, was given before the Division of Physical and Inorganic Chemistry, 44 were read before the Biological Section, 27 before the Industrial Chemists and Chemical Engineers, and 17 before the Division of Organic Chemistry.

Twelve papers were presented before Section D in the symposium on aeronautics, and 10 were given on the regular program. Before Section E, the program consisted of 5 papers on Economic Geology, 7 on Structural Geology, 7 on Glacial Geology and 6 on Geography. Section F and the Central Branch of the American Society of Zoologists met regularly in joint session, with a program containing 43 papers. Fifty-eight titles appeared on the programs of the Entomological Society of America and the American Association of Economic Entomologists. The meetings of the Association of Horticultural Inspectors were given largely to reports of committees and to discussions. Five zoological papers were also presented at the meetings of the American Microscopical Society.

Section G, the Botanical Society of America, and the American Phytopathological Society met regularly in joint session, except on Friday morning, when simultaneous sessions of the section and the pathologists were necessary to complete the program. The features were the special addresses before the joint session on Wednesday afternoon, under the auspices of Section G, and the symposium on plant pathology at the College of Agriculture on Thursday, under the auspices of the Botanical Society. An interesting innovation was a conference on botanical teaching at the close of the botanical dinner on Thursday evening. Seventy-one papers were presented at the botanical sessions. The program of the Sullivant Moss Society consisted of 12 papers on mosses, liverworts and lichens. The American Nature-Study Society held three symposia on Friday, devoted to the subjects: "The School Garden as a Nature Study Laboratory," "Natural History Museums in Relation to Nature Study Instruction" and "The Organization of Nature Study."

Section H held no meeting, but the American Psychological Association and the Western Philosophical Association were both in session. The two met in joint session on Thursday, and in session with Section L on Wednesday. Thirty-four papers were presented. Twelve papers were read before Section I. The symposium before Section K was devoted to the subject, "Diseases due to Filterable Organisms." In addition, a number of papers were presented in the general program. Section L met in joint session with the American Psychological Association, for the discussion of the topic, "Educational Psychology," and in joint session with the American Federation of Teachers of the Mathematical and Natural Science to discuss the topic, "Methods of Testing the Results of Science Teaching." The section also held a general interest session on university extension teaching, in addition to the program of 7 reports on investigations in education. The meeting of the American Federation of Teachers of the Mathematical and Natural Sciences was devoted to the reports of committees on various subjects.

The important actions taken by the council at the Minneapolis meeting were as follows:

1. A committee on organization and correlation was appointed, consisting of nine members, of which four were to be members of the council. This committee reported the following recommendations: "The committee recommends to the council that each section, when the corresponding affiliated society is meeting at the same time and place, shall confine its sessions at the annual meeting preferably to half a day or at most to two half days, and that the sectional program shall include the address of the vice-president and a series of papers of general interest prepared by in-

vitation issued by the committee of the section." The recommendation of the committee was adopted, and on motion the council resolved further that it regards with especial favor holding all sessions under the joint auspices of the section and the appropriate affiliated society

2 A resolution was adopted as follows

WHEREAS serious injury and injustice would be done to scientific societies and scientific journals should such societies be forbidden to send scientific journals to members by second class postage

Resolved, that the American Association for the Advancement of Science, meeting in Minneapolis, request the Postmaster General and the Committees on the Post Office of the Senate and the House of Representatives to give careful attention to the effects of any ruling of the department that might limit the advancement and diffusion of science in this country

Resolved, that copies of these resolutions be sent to the Postmaster General and to members of the Committees on Post Office of the Senate and the House of Representatives

The officers of the association were instructed, officially and in the name of the association, to take such steps as will aid in the passage of the Dodds bill

3 The election of fellows of the association was placed upon the basis of professional work in science, in the hope that greater uniformity will thus be secured in the action of sectional committees

4 The usual grant of $200 was given to the Concilium Bibliographicum, and an additional grant of $75 to Professor G. J Peirce for continuing the study of organisms in brines

The general committee voted to hold the next meeting of the association in Washington from December 27 to December 30, and to reaffirm the action contemplating meetings in Cleveland and Toronto for 1912 and 1913 respectively The following officers were chosen for the Washington meeting·

President—C E Bessey, University of Nebraska

Vice-presidents—Section A, Mathematics and Astronomy, E B Frost, Yerkes Observatory, Section B, Physics, R A. Millikan, Chicago University, Section C, Chemistry, F K Cameron, Department of Agriculture, Washington, Section D, Mechanical Science and Engineering, C S. Howe, Case School of Applied Science; Section E, Geology and Geography, Bohumil Shimek, University of Iowa, Section F, Zoology, H F Nachtrieb, University of Minnesota, Section G, Botany, F C Newcombe, University of Michigan, Section H, Anthropology and Psychology, G T Ladd, Yale University, Section I, Social and Economic Science, no election, Section K, Physiology and Experimental Medicine, Dr W T Porter, Harvard University, Section L, Education, E L Thorndike, Columbia University

General Secretary—John Zeleny, University of Minnesota

Secretary of the Council—T S Palmer, Washington, D C

FREDERIC E CLEMENTS,
General Secretary

SECTION A—MATHEMATICS AND ASTRONOMY

As the Chicago Section of the American Mathematical Society held its regular Christmas meeting in affiliation with the American Association, the special program of Section A did not include any technical mathematical papers The "general interest session" of the section was held on Wednesday afternoon This was a joint session of the Chicago Section of the American Mathematical Society and of Section A, and the program of the session consisted of the vice-presidential address by Professor E W Brown, of Yale University, and the papers by F R Moulton and E B Frost, of the University of Chicago

A very interesting feature of the meeting was the joint session of Sections A and D and the Chicago Section of the American Mathematical Society This session was devoted to the report of the committee of twenty, appointed at a similar meeting in Chicago, in December, 1907, on the question The teaching of mathematics to students of engineering. During the evening preceding this meeting members of Sections A, B and D and the Chicago Section of the American Mathematical Society discussed informally questions relating to this report and were afforded excellent opportunities to become better acquainted.

In the absence of their authors the papers by J E Siebel and H. E. Wetherill were read by title. The papers by J. A. Parkhurst and Percival Lowell were read by E. B Frost and Frederick Slocum, respectively. All the other papers of the

following list were read by the authors during the three sessions of Section A.

1 "The Relations between Jupiter and the Asteroids" (vice presidential address), E W Brown

2 "The Contributions of Astronomy to Mathematics," F R Moulton

3 "On some possible Bases for the Spectral Classification of Stars," E B Frost.

4 "Apparent Photographic Star-streams and their Relations to some of the Vacant Regions of the Sky," E E Barnard

5 "Photographic Observations of the Surface of the Planet Mars," E E Barnard

6 "An Integrable Case in the Problem of three Bodies," W D MacMillan

7 "Photographic Position of 127 Stars within Ten Minutes of the Ring Nebula of Lyra," F P Leavenworth.

8. "Preliminary Report on the Evidences of Circulation in the Atmosphere of the Sun, Derived from the Study of Solar Prominences," Frederick Slocum

9 "On the Choice of Standard Stars in Photographic Stellar Photometry," J A Parkhurst

10 "The Oblateness of the Earth," J E Siebel

11 "Dials for Calculations," H E. Wetherill

12 "Parallax of Ring Nebula of Lyra from Photographs taken at the Lick Observatory," B. L Newkirk.

13 "Spectrum of Ring Nebula of Lyra," K. Burns.

14 "The Sun as a Star," Percival Lowell

The addresses by E W Brown and F R Moulton will appear in SCIENCE Abstracts of the other papers follow, the numbers preceding these abstracts correspond to the titles in the list given above.

3. There are numerous possibilities in the selection of a basis for the establishment of a system of stellar classification according to spectra. Emphasis may be laid upon the differences of a physical sort between stars, such as temperature, as inferred from the extension of the spectrum toward the violet, or from measurements of the radiation at different wave-lengths or differences of a chemical sort may be made the criterion, according to the elements found in the spectra. Again, theoretical reasons based upon the dynamics of the case may be regarded as especially important; or deductions from some hypothesis of stellar evolution may be considered as the most logical basis for discrimination. Even the motions of the stars, or the space within which they are found, may have a bearing upon the subject, as, for instance, in the case of the streams of stars recently discovered and lately much discussed

The paper gives a brief general discussion of some of these points, with lantern illustrations of different celestial spectra

4 There are frequently seen, on wide field photographs of the sky, lines of stars either straight or curved, and sometimes in the form of more or less complete ellipses with a brighter star in a focus of the ellipse It is probable that most of these stars are not physically connected, and appear so only by perspective But it does not seem probable that all these appearances are due to fortuitous circumstances alone

Besides these lines and curves of stars, so striking in some parts of the sky, there are apparently broad streams of stars which seem to have a common trend This appearance usually occurs in a very dense region, and resembles that which might be produced by the sweep of a giant broom In some cases these "sweeps" are apparently connected with vacant regions, as if there were a common drift of the stars away from these places A striking case of this kind occurs in *Scutum*, where the appearance is that of streams of stars diverging away from or converging to a vacant region at this point

5 During the opposition of Mars in 1909 efforts were made to secure photographs of its surface features with the 40-inch refractor and a negative enlarging lens made by Brashear For this purpose a yellow color screen, made especially for the work by Mr. Wallace, with Cramer instantaneous isochromatic plates, was used. Though the exposures were short (three or four seconds), it was found necessary to guide on the planet during the exposure In the eyepiece of the long-focus (61½ feet) guiding telescope two cross wires (spider threads) were inserted. In making the photographs the polar cap of the planet was bisected by these cross-lines, and the telescope held firmly in this position by pressure exerted at the eye-end of the 40-inch. The cross wires are on a perforated strip of sheet brass (with an opening a couple of inches in diameter) that can be shoved back and forth through a slit in the adapter carrying the eyepiece. It is also arranged to move in position angle.

For photographing Jupiter and Saturn, where there is nothing definite to guide on, the intersection of the wires can be made to bisect a satellite, after the image of the planet has been

properly adjusted in the camera. The wires are then held firmly on the satellite, as in the case of the polar cap of Mars

The conditions of seeing necessary for success in this class of work were almost entirely absent during the opposition of Mars. There was only one night, 1909, September 28, on which the conditions were favorable, and this for a short time only The best results are therefore meager, but the promise of success is good when conditions will permit the best work.

The photographs of September 28 show the region of the Syrtis Major. They contain essentially all the details that could be seen with the same telescope visually.

6 Dr MacMillan shows that if two of the masses are finite and equal and revolve about their common center of gravity in circles, and if the third mass is infinitesimal and is projected in the axis of revolution of the two finite bodies then the motion of the infinitesimal body can be determined by means of elliptic functions If the velocity of projection is not too great the motion of the infinitesimal is periodic and it is shown how to construct periodic series representing the motion.

7 Twenty-two photographs were made with the 10½ inch telescope of the University of Minnesota between the years 1897–1910 Ten plates were measured and reduced to standard of October 19, 1909 The faintest stars measured were about fourteenth magnitude. No variability in brightness was detected. The proper motions are all less than $0''.1 \pm 0''.01$ per year The measures have not yet been discussed for parallax.

8 From a study of 3,300 solar prominences, by Dr Slocum, photographed in the light of the H-line of calcium with the Rumford spectroheliograph of the Yerkes Observatory during the past seven years, 1,100 were found which by their shapes or movements indicate a horizontal circulation The tendency is poleward between latitudes 20° and 55°, equatorward beyond 55°, and neutral near the equator The contrast of tendency is greater in the northern hemisphere than in the southern in the ratio of 2 to 1 The average height above the chromosphere of the prominences studied is 0′.7 or 30,000 km The earlier plates do not afford data for determining velocities From the later plates low prominences of the cloud type give apparent velocities from 1 to 10 km per second. One detached cloud at a height of 7′ or 300,000 km shows a horizontal velocity of 50 km per second, while eruptive prominences have been observed the north and south horizontal component of whose velocity reaches 200 km. per second.

9. The paper by Mr. Parkhurst deals with the relative advantages of two proposed systems of standard magnitude stars; those in the neighborhood of the pole, and the white stars in the particular region photographed It compares the possible errors arising from differences of transparency of the sky when a distant region is referred to the polar standards with the errors due to the magnitudes of stars found in the visual catalogues of the region photographed, and the uncertainties due to the allowance made for spectral type of these standards

10 In accordance with experimental demonstrations devised by Dr Siebel, the ellipticity of the earth may be considered as the result in part of the withdrawal of a greater amount of kinetic energy in one of the three directions (in which the molecular motions of a liquid subjected only to its own internal forces may be resolved) during its congelation or solidification. For the experimental demonstration of this phenomenon a drop of water is suspended in a mixture of Beechwood Creosote and ether, which is cooled sufficiently to make the drop of water congeal almost at once The moment when this takes place, the perfect globular shape of the drop changes into an ellipsoidal form, whereby the vertical diameter of the same is reduced at least one fourth, the now solid and flattened drop, on account of the lower density acquired, rises slowly to the surface.

11 A particular kind of dials useful in certain calculations were discussed in the paper by Dr. Wetherill.

12 The present investigation is based on measures of seventeen plates made with the Crossby reflector of the Lick Observatory. It proves impossible to separate the parallax from atmospheric dispersion without further observational material which the Lick Observatory will provide. In addition to masking the effect of parallax the atmospheric dispersion produces shifts of the position of the central star amounting to $0''.2$.

Photographs made with a reflector are probably more subject to the effects of atmospheric dispersion than those made with a refractor.

Certain hitherto unexplained discordances in visual observations of the central star may be due to dispersion.

13. True photographs of the nebula were taken with the slitless spectroscope of the Crossby

reflector of the Lick Observatory Spectrum on the stained plate was compared with spectra on ordinary plates. The spectrum of central star is continuous and like spectra of central star of planetary nebulæ. The spectrum of central star is relatively stronger in ultra-violet light than the bluest of the Orion type of stars The distribution of elements in the nebulous ring are probably not identical.

14 The conclusions reached in the paper by Percival Lowell are That parallaxes beyond 0".067 are too small to be trustworthy, and that the masses of those stars for which alone we have dependable data are, in the mean, almost exactly the same as that of the sun

The following members of Section A were elected as fellows M J Babb, E W Bass H Y Benedict, G D Birkhoff, A B Chace, Arnold Dresden, Eric Doolittle, J C Duncan, T C Esty, Max Fischer, G W Hartwell, H G Keppel, A S Hawkesworth, T H Hildebrandt, N J Lennes, W H Maltbie, Max Mason Helen A Merrill, E J Miles, A B Pierce, A R Schweitzer, F. H. Seares, Mary E Sinclair, Clara E Smith, E R. Smith, A W Stamper, A L Underhill, C E Van Ostrand, F W. Very, W D A Westfall, E J Wilczynski, F B Williams, T W D Worthen, E I Yowell The section elected President E O Lovett member of the council, President C. S Howe member of the sectional committee, and Dean H. T Eddy member of the general committee. On recommendation of the sectional committee Professor E B Frost, director of the Yerkes Observatory, was elected chairman of the section.

G A MILLER,
Secretary of Section A
UNIVERSITY OF ILLINOIS

SOCIETIES AND ACADEMIES

THE BOTANICAL SOCIETY OF WASHINGTON

THE 68th regular meeting of the society was held at the Cosmos Club, Friday, December 16, 1910, at eight o'clock P.M. President W J. Spillman presided. Thirty members were in attendance. H A. Edson, E P. Humbert, F. J Pritchard and W H Long were admitted to membership.

The following papers were read·

Propagation of Sea Island Cotton DR. W. H EVANS

An account was given of the work of the Hawaii Agricultural Experiment Station, with cotton, especial attention being called to the vegetative propagation of the cotton plant At the Hawaii Station experiments with Sea Island and Caravonica cottons have been in progress for several years, and it has been found advantageous to grow them as perennial crops, pruning the plants every year, the Sea Island to about six or eight inches of the previous year's growth and the Caravonica about one half the growth of the season preceding After pruning, the plants start growth rapidly and within five months are producing squares By paying attention to the time of pruning, harvesting can be regulated to some at a time when picking can be most economically done In the experiments described above, the prunings have been taken as cuttings, rooted, and then set into the field In this way a number of superior strains have been propagated without the possibility of crossing As the older plants yield fifty to one hundred cuttings at a pruning and practically all root quickly, this is not as slow a method of propagating as would be at first thought

In addition to increasing cotton by cuttings, it has been found possible to propagate it by budding and grafting, and a considerable number of plants have been successfully top worked with especially fine strains of cotton

Pecan Scab M B WAITE

The pecan, being a native forest tree, is not as subject to destructive outbreaks of fungous diseases as other cultivated nuts and fruits It is native of the Mississippi Valley as far north as Iowa and central Illinois, and extends eastward into Alabama and westward into Texas. It is mainly planted in commercial orchards throughout the cotton belt, but particularly in the district where sugar cane can be cultivated It is not expected, therefore, that the pecan should have such destructive diseases as the bacterial blight of the English walnut, pear-blight of the pear and apple, yellows of the peach tree, or the black rot, downy mildew or phylloxera of the European grape when the latter is grown in the eastern United States

There is an apparent exception to this in the pecan scab, caused by the fungus *Fusicladium effusum* Winter This exception comes about through the transfer of seedlings and horticultural varieties, such as San Saba and Sovereign which originated on the western limit of the pecan in Texas, where the summers are dry, to the humid conditions of the gulf coast states and the Carolinas The Texas group of varieties are

often severely attacked by the scab fungus, particularly on the nuts, and the crop partially or totally destroyed The *Fusicladium* attacks the young leaves as they unfold in the spring The young leaflets and the leaves are successively attacked through the growing season while they are developing Each leaf and leaflet as it reaches maturity becomes immune, or nearly so, to the fungus infections The fungus also attacks the young growing twigs, but particularly the nuts The nuts continue to develop through the summer and remain susceptible until late in September

Infections take place at definite periods, namely, the warm, rainy, humid spells that occur so frequently in the southeastern states An interesting feature was found in relation to the life history of the disease, namely, that a plant louse which becomes common on the pecan in May punctures the epidermis in a regular way along the veins and veinlets The punctures of this plant louse are used as points of entrance by the *Fusicladium*. The fungus can also enter in the direct way and such diseased spots are irregularly located over the leaves, fruit and twigs, but the spots due to aphis infections are arranged in regular lines along the veinlets and far exceed in number all other spots on the leaves The fungus evidently is also assisted in its germination and growth by the honey dew copiously secreted by these aphids

Spraying experiments showed that bordeaux mixture controlled the scab thoroughly and is probably the best fungicide for treating it. Diluted lime sulphur solution also controlled the scab nearly as well and killed the aphids, thus making it a promising mixture to use, at least in part of the treatments The unfortunate fact that the nuts remain susceptible throughout the summer makes treatment difficult and expensive, so that four or five, and even six sprayings may be necessary for success

Extensive observations through the south by a number of pecan students, as well as the experience of practical pecan growers and nurserymen, have shown that a large number of varieties are reasonably resistant to this disease. These varieties have nearly all originated from Louisiana stock or at least from trees grown in the humid regions adjacent to the Mississippi and the gulf. Since many of the finest paper-shell varieties are commercially resistant to the scab fungus, they should, of course, be selected for cultivation in the humid southeastern states Furthermore, instead of recommending the treatment by spraying of the badly scabbing varieties, it is suggested that these varieties, as well as susceptible seedlings, be top-worked to resistant sorts

Bubani's Flora Pyrenæa Dr. E L Greene.

W W Stockberger,
Corresponding Secretary

THE PHILOSOPHICAL SOCIETY OF WASHINGTON

The 40th annual meeting (686th regular meeting) was held on December 17, 1910 President Woodward in the chair.

After hearing the reports of the secretaries, the treasurer and the auditing committee, the annual election for the selection of officers for the calendar year 1911 was taken up, and the following officers were duly elected

President—A L Day

Vice-presidents—L A Fischer, C G Abbot, E B Rosa and G K Burgess

Treasurer—L J Briggs

Secretaries—R L Faris and W J Humphreys

General Committee—E Buckingham, W S Eichelberger, E G Fischer, B R Green, R. A Harris, P G Nutting, F A Wolff, W. A DeCaindry and J A Fleming

After the election of officers a buffet luncheon was served

R L Faris,
Secretary

THE AMERICAN CHEMICAL SOCIETY
NORTHEASTERN SECTION

The one hundredth meeting of the section was celebrated by a dinner held at the Exchange Club, Boston, on December 16. President Wilder presided, and there were one hundred members and guests present

The evening was devoted to a consideration of "The Conservation of our Natural Resources" Hon Curtis Guild, Jr, ex-governor of Massachusetts, spoke on the conservation of forests for the sake of both timber and water, and he urged the duty of the federal government to provide national reservations in the east as well as in the west.

Mr H M Wilson, of Pittsburgh, assistant chief of the Bureau of Mines of the Department of Commerce and Labor, described the work of this bureau and dwelt particularly on the progress in the prevention of coal mine disasters and in the care of injured miners

Kenneth L Mark,
Secretary

SCIENCE

FRIDAY, JANUARY 20, 1911

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THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

THE RELATIONS BETWEEN JUPITER AND THE ASTEROIDS[1]

THE story of the smaller bodies which form part of the solar system belongs altogether to the nineteenth and twentieth centuries The discovery of Ceres on the first of January, 1801, followed by those of Pallas, Juno and Vesta, in the next six years, gave promise of a new field for the astronomer Nearly forty years, however, elapsed before any more were found The improvements in star maps about the middle of the century enabled observers to detect new objects more easily, so that from 1845 to 1860 over sixty were captured Since that time scarcely a month but brings one or more to the list, and now nearly 700 are known But this by no means completes the tale New asteroids are constantly being recorded and receive a temporary designation and are perhaps observed two or three times In fact the number of new discoveries has become too great for the few astronomers interested to obtain orbits of sufficient accuracy for future observation It has become a question whether the search should be continued, and if so what plan should be adopted for the computation of the orbits

To the student of celestial mechanics these small bodies furnish many interesting problems The older planets and our own moon have had such thorough attention accorded to the study of their motions, that the outstanding difficulties are almost solely in the last refinements and

[1] Address by the retiring vice president of Section A, American Association for the Advancement of Science, Minneapolis, December 28, 1910.

the most minute consequences of the laws under which they run their courses. Their orbits differ but little from circles, and for practical purposes the series of terms which represent their motions are easily obtained, even if the process of so doing may sometimes be a lengthy one. Far otherwise is it with the asteroids. Many of their orbits are highly eccentric and inclined at large angles to the plane near to which the large planets circulate. But the most interesting problems are those which arise from the near presence of the second largest member of the solar system, Jupiter, whose mass is but little less than one thousandth that of the sun.

Jupiter, great as it is compared with the other planets, is yet small relatively to the central body which mainly controls their movements. In general its average effect on a body which does not come very near to it must be small. Under certain circumstances, it may cause very considerable deviations for a time, even in planets which do not approach it very closely. Astronomers have generally divided the disturbances of the motion of one body produced by another into two classes, periodic and secular. The latter are properly those which change the motion always in the same sense so that they would ultimately cause a change to another type of motion. As a matter of fact, however, the division is arbitrary and in a strict sense inaccurate. So far as we know, all the disturbances produced in our solar system by gravitation are really periodic, but some of the periods are so long, extending to thousands and ten thousands of years, that it is more convenient in the short space of time during which we desire to know the motion to treat certain of them as secular.

These long period deviations are often of very considerable extent. They may be divided into two classes, "proper" and "accidental." In the former all the bodies which have the same type of motion have the long period terms, for instance, the slow oscillations of the eccentricities of all the planets due to the attractions of one on another are of this type and they arise principally because the masses of the planets are small compared with the mass of the sun.

The accidental terms are those arising from a synchronism of periods. They should be regarded perhaps as a result of the defects of our mode of representing the motion in symbolic form. However this may be, their presence causes a real practical difficulty which must be solved. We regard the motion of each body as having a principal period of revolution round the sun in a circle, with deviations from circular motion due to the eccentricity of the orbit, these deviations having periods which are multiples of the principal period. Thus there will always be some period in the motion of one planet very near to a period in the motion of another planet. When the degree of approximation we require is settled there will only be a limited number of accidental corresponding periods. If the difference between the two periods is small, a term of long period arises, and the amplitude of the oscillation is nearly proportional to the long period (or to the period squared) and it might seem that when the period became infinitely great the amplitude would also tend to infinity. In physical terms the motion would be unstable. It is not so in general. When the amplitude begins to approach very large values the motion may still be stable. If it is, one of two things has occurred. Either the difficulty is a symbolic one, that is, our mode of representing the motion is defective for large oscillations, and the difficulty can be bridged by choosing some other analytical

representation, or the type of the oscillation may completely change, when the latter happens, it is generally necessary to change also the symbolic representation

A change in the character of an oscillation which does not cause real instability can be illustrated by a simple example This illustration, while it has no immediate bearing on the question of synchronism, does show the change in the character of the motion which is sometimes produced by a synchronism

Let us consider the motion of a rod, one end of which is pierced to admit a horizontal axle so that the rod can rotate in a vertical plane Suppose that the rod is rotating so rapidly in one direction (called positive) that it makes many complete revolutions in a second There will be slight differences of velocity at various points, differences which can be expressed quite accurately by a single harmonic term Owing to frictional resistances the speed will gradually diminish With diminished velocity the difference between the velocities at the highest and lowest points increases in a ratio which varies very nearly in the inverse ratio of the average speed When the speed has so far decreased that the ratio of the velocity at the top to that at the bottom is very small, we can no longer express the differences of velocity approximately by a single harmonic term, but must include the higher harmonics At the critical stage when the velocity at the top is just zero, the representation fails From our knowledge of the physical side of the problem we know that this failure is not owing to the defects of the representation, but that it is due to a change in the character of the motion The rod ceases to make complete revolutions and begins to oscillate to and fro with diminishing amplitude until it finally comes to rest at the lowest point There is another side to this example which is important for what follows The difference between the velocities at the highest and lowest points is continually increasing, but it does not become infinite. At the critical stage it reaches a maximum value and, becoming discontinuous at this point, has its range suddenly doubled The minima and maxima are nearly equal in magnitude but of opposite signs The range then diminishes until it reaches the limit zero The critical point is, of course, a position of unstable equilibrium and then any small force which may be acting, but which could previously be neglected, may determine the character of the future motion

If we neglect the resistance of the air and imagine that the axle on which the rod is mounted is made to turn in the opposite sense to the original rotation of the rod, the slight friction between the rod and its axle will gradually tend to stop the motion But when the rod is nearly at rest close to its highest position one of two things will happen, either the rod will begin to oscillate as before, or after the first oscillation it will be carried past the highest point and begin to rotate in the same sense as the axle with increasing average velocity.

On the analytical side we have to notice mainly one point Before the critical stage the angular motion is expressed by an angle which increases continuously with the time As the motion gets slower the variations from uniform increase become more and more marked. After the critical stage is passed and the rod is oscillating to and fro, the angle itself varies between two limits which are less than 360° apart, finally settling down to a constant value If, however, the rod begins to make complete revolutions in the opposite direction, the angle diminishes continuously with the time, and its variations from uniformity

become smaller as the mean angular velocity increases negatively It is true that we are accustomed to express the small oscillations of a pendulum by means of angles which increase uniformly with the time, but it is the angle of oscillation which is so expressed and this angle varies between finite limits

I must apologize for insisting at such length on an elementary illustration with which you are all familiar Though it serves to make clear the types of deviations which Jupiter may induce in the motion of an asteroid, the analogy must not be pushed too far It fails to illustrate what may happen to a planet when the stage which corresponds to the rod at rest near the lowest point of the circle has been passed And it takes no account of the numerous short period changes which the planet experiences and which can not be altogether neglected Moreover, forces may be present which may tend to increase the oscillatory motion, so that after a period of hesitation the planet may be compelled to settle down into a motion which corresponds to a rotation of the rod in the negative direction, and this independently of the minute forces which may determine its motion just after the velocity has first become zero

These periodic changes, in which the variable is constrained to remain between finite limits, are generally known as librations The familiar example furnished by the motion of the moon relative to its center of mass is of course a result of the synchronism of its period of rotation about its axis with that about the earth The delicate balancing of the conditions necessary for a libration makes the term unusually appropriate in the cases of the motions of the asteroids

All the earlier discoveries indicated that the smaller members of the solar system, which were not satellites of some planet, occupied a more or less well-defined region between the orbits of Mars and Jupiter But the distribution was by no means continuous It was soon seen that if the mean periods as then determined were arranged in order of magnitude there were gaps in the list which could not be explained by the law of averages It was, I believe, Professor Kirkwood, of Indiana, who first pointed out that these gaps existed at or near the places where the periods are commensurable with the period of Jupiter With the increasing number of planets discovered the discontinuities have become more accentuated In general, the smaller the two whole numbers which represent the ratio, the wider is the gap It has been known that such cases of commensurability produced great difficulties in computation and that the ordinary methods failed The idea was this—near commensurability of a forced period and a natural period produces large deviations, growing larger the more closely the whole number ratio was approached It was thought that when the ratio became exact the deviation would be infinite, or in physical language the orbit was unstable But the deviation, at any rate so far as at present known, does not tend to an infinite limit There appears to be a maximum value which can not be exceeded, and if the planet is so started that this maximum is passed, the ratio of the two periods becomes exact and oscillations about this exact ratio occur The natural period becomes a forced period The analogy to the case of the rod is evident

As early as 1812 Bessel had pointed out that the periods of Jupiter and Pallas are very nearly in the ratio of 7 to 18 and that the attraction of Jupiter must maintain this exactly, that is, the deviations from it would be oscillatory and not secular New-

comb invoked the same idea to combat the opinion that instability was the cause of the gaps in the distribution of the asteroids In a word, the oscillations become librational and have finite limits, or in physical terms, the motion is stable. Thus instead of causing an absence of asteroids at the positions of commensurability, with this idea the action of Jupiter should rather tend to increase the number, since a definite proportion of those very near would be compelled to librate about the exact ratio. It is not clear to what extent the published elements are dependent on the terms of very long periods, but the main issue is not affected, none of the known asteroids in the principal lacunæ appear to librate.

In order that you may see the extent of the inequalities in the distribution I shall throw upon the screen a chart (Fig 1) in which the abscissæ represent the mean periods in days and the ordinates the number of planets with those periods. Each vertical division represents ten days and the number of planets whose periods fall within any division is shown by the height of the curve at that place. There are about 630 asteroids represented. The curve falls to zero at 2,160, 1,850, 1,730 and 1,440 days and there are less well marked minima in other places. Now these four minima include the places where the periods are in the respective ratios of 2:1, 7:3, 5:2, 3:1 to the period of Jupiter. There are also indications of minima at the places where the ratios are 8:3, 7:2, 9:4. These are all the whole number ratios within the range with a denominator less than 5.

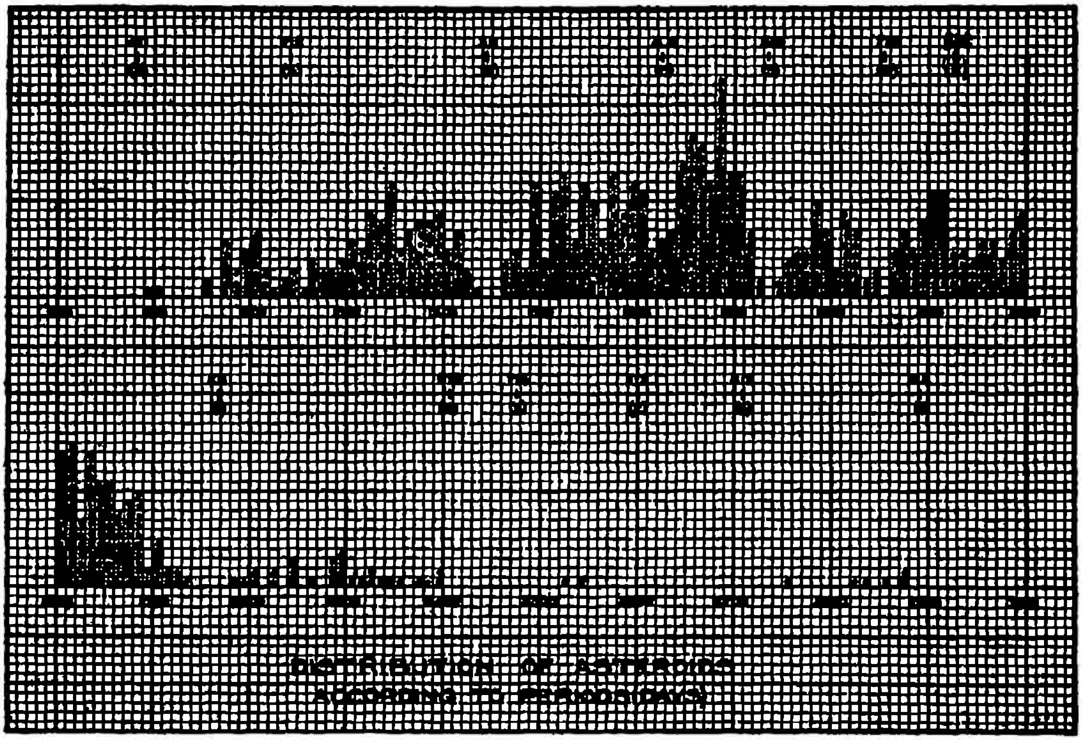

FIG. 1

I am going to speak more particularly

of the gap at the ratio 2·1, this being the most extended of all. Here there are no known planets with periods between 2,120 and 2,204 days; the exact ratio is 2,166, not very far from half way between the two sides of the gap. The comparatively few planets on the outer side of the gap may be a consequence of the general distribution, but the sudden increase in the number on the inner side suggests that other causes have been at work.

In attempting to give an explanation of the phenomena by gravitational forces alone, I must on this occasion omit any mathematical discussion and simply lay before you the main results at which I have arrived. Until this discussion is published in detail, you will naturally reserve your opinions as to the validity of the argument. The reasons for presenting the results in advance of the methods will be evident in the course of my remarks.

The motion of an asteroid near the critical places depends mainly on two quantities, the apparent eccentricity of the planet at any time and the difference between the actual period and the period which is twice that of Jupiter. In the theory both these are quantities such that if at any moment the attraction of Jupiter were suddenly annihilated, the asteroid would continue its motion in an elliptic orbit round the sun with this period and eccentricity. They are thus determined by the position and velocity of the planet at the moment. The attraction of Jupiter causes the temporary period and eccentricity to vary and it is the variations of those two quantities that are the main factors. Now the equations which I have obtained give the principal parts of these two quantities in the form of the square roots of variable functions. In order that they may be real these variable functions must always be positive. One of two things must happen. Either the variability of the functions is forced, that is, it is independent of the motion of the asteroid, or it is free. In the latter case the motion of the asteroid is limited. Under certain general conditions it has long been known that the equation giving the period is to a large extent free so that the asteroid may librate or not, according to the values of the constants entering into the equation, and there is nothing to prevent the constants from having such values. But the period also depends on the eccentricity, and the possible variations of this quantity can not be neglected.

The eccentricity and the difference of the actual period from that of Jupiter are really connected by two equations which can not be independently treated. The eccentricity is also dependent on the short period terms which from this point of view may be considered as of forced period, since the periods of the larger terms are very nearly multiples of the period of Jupiter. I find from this that the eccentricity can not permanently remain below a certain limit and consequently that if a libration of the period about the critical ratio occurs, it can not have a very small amplitude. Referring to the analogy of the rod, we discover the presence of forces which prevent the angle of oscillation of the rod to and fro from descending below a certain finite value. The oscillation can not become infinitely small. This result is in agreement with a theorem proved by Poincaré that no periodic orbit at such a critical place exists.

Reducing to numbers, I find that the lower limit of the slow variation of the eccentricity for an asteroid just before it reaches the critical stage between libration and non-libration is about one twentieth and that at some time it must become as large as one seventh. If there is an asteroid which has passed this stage and is

librating, the upper limit of the eccentricity is at least one fifth. Thus at some time the asteroid must have a comparatively large eccentricity These large changes in the eccentricity take place very slowly Hence the asteroid will during one interval perform many revolutions round the sun in a nearly circular orbit and during another interval many revolutions in a quite eccentric orbit

It has been mentioned that these large variations of the eccentricity are of very long period—the same as that of the libration—and that they increase with the extent of the libration. One may regard the asteroid as slowly extracting energy from Jupiter (or losing it to Jupiter) until it has accumulated (or lost) a maximum amount, when the reverse process takes place Jupiter, owing to its immense mass in comparison with that of the asteroid, will not have its motion sensibly altered by the loss or gain If the type of motion changes when this loss or gain is near a maximum, the asteroid may in future so move that the energy never returns to its original source The type must then be unstable

In my discussion all powers of the eccentricity but the lowest have been neglected. This omission prevents us from obtaining a proper representation of the motion when the eccentricity has risen to so large a value as one fifth, and it is to be remembered that this is the lowest maximum which any librating asteroid can have.

If we take into account higher powers of the eccentricity, it is seen that the extent of the variation must be increased to a considerable extent. I have not so far been able to obtain numerical results beyond this stage. The indications are that the eccentricity increases so much at some time that the stability of this type of motion is threatened and that the asteroid is compelled to take up some other type which is more stable

Although the facts I have stated do not furnish a proof that librations round the ratio 2 1 can not exist, they at least indicate the direction in which stability becomes doubtful. The usual analytical representation, which is possible for moderate librations of the period, fails where the eccentricity becomes very small or great, and the failure is partly due to the short period terms The question which requires solution is whether the failure with large eccentricities is merely a defect of the mode of representation, or whether it is due to actual instability My own impression is that the limits of stability of libration about the principal ratios are so near together, that the chance of an asteroid lying between them is very small This impression is, however, not independent of the observations There are no known asteroids which perform librations round the ratio 2 1 and there are none which approach libration very closely The lacuna in the distribution doubtless admits of other interpretations, but the framing of hypotheses to explain it must properly await a more complete discussion of the consequences of the law of gravitation.

The distribution of the asteroids on either side of the gap furnishes certain tests. The theory indicates that asteroids which initially had large eccentricities are more likely to librate than those with small eccentricities. If the large eccentricities, as I believe, tend to become unstable, it follows that the gap must be wider for them than for the small eccentricities. The next slide (Fig. 2) shows the distribution of eccentricities greater and less than one fifth, round the ratio 2:1. It shows also the distribution by differences of .05 of the eccentricities above .20. The tendency of the asteroids to be more distant from the

gap as the eccentricities increase is very noticeable

Again, according to the theory of a number of asteroids started at various times with the same eccentricity and with periods which bring them near the ratio on the inner side but not such as to allow them to librate, we shall at a future time be more likely to find the values of the eccentricity large at a distance from the gap and small near the gap The reverse would occur with asteroids on the outer side. The observations confirm this result in a marked degree on the inner side The number of known asteroids on the outer side is too small to furnish a test, but if the observed distribution is typical of the real distribution the theory would be confirmed. The need of more asteroids, especially on the outer side, is evident

That these peculiarities are not consequences of the general distribution of the large eccentricities will appear from the next slide (Fig 3) It will be seen that there is a notable deficiency near to the gap and that this deficiency is much more marked than the general distribution would lead one to expect.

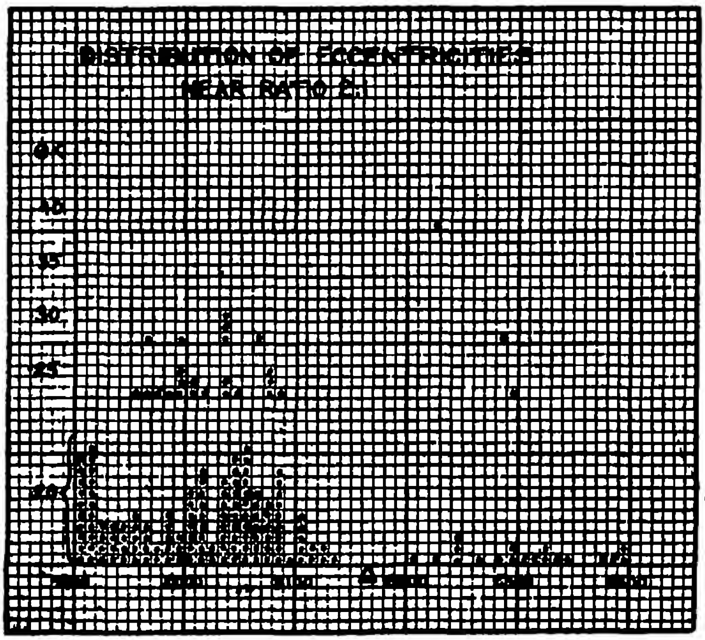

Fig 2

Further support is derived from the inclinations With the ratio 2·1, there should be no very noticeable difference in the distribution of large and small inclinations round this gap, and the next slide (Fig. 4) shows this The curves for i greater than 10° can be compared with those for i less than 10° and also with those for each 5° greater than 10° It is seen at once that there is no selection of the large or small inclinations. The distribution for large inclinations appears to follow the same general law as the distribution for small inclinations. If we refer back for a moment to the slide giving the distribution of the eccentricities, it will be seen how different the two distributions are.

I have hitherto spoken solely of the ratio

2:1. Similar results can be obtained concerning the distribution round the other ratios, but these I must dismiss in a few words, mainly because the details have not yet been worked out It can be stated, however, that the inclination can not in general be neglected when the difference between the two terms of the ratio exceeds unity. Nevertheless, the general result an eccentricity greater than one fifth. This is nowhere more strikingly illustrated than at the values 7 3 and 9:4 There is a large maximum of small eccentricities between these ratios, and only three asteroids with eccentricities so great as twenty-five in the same space A similar phenomenon is observable between the ratios 7 2 and 4 1.

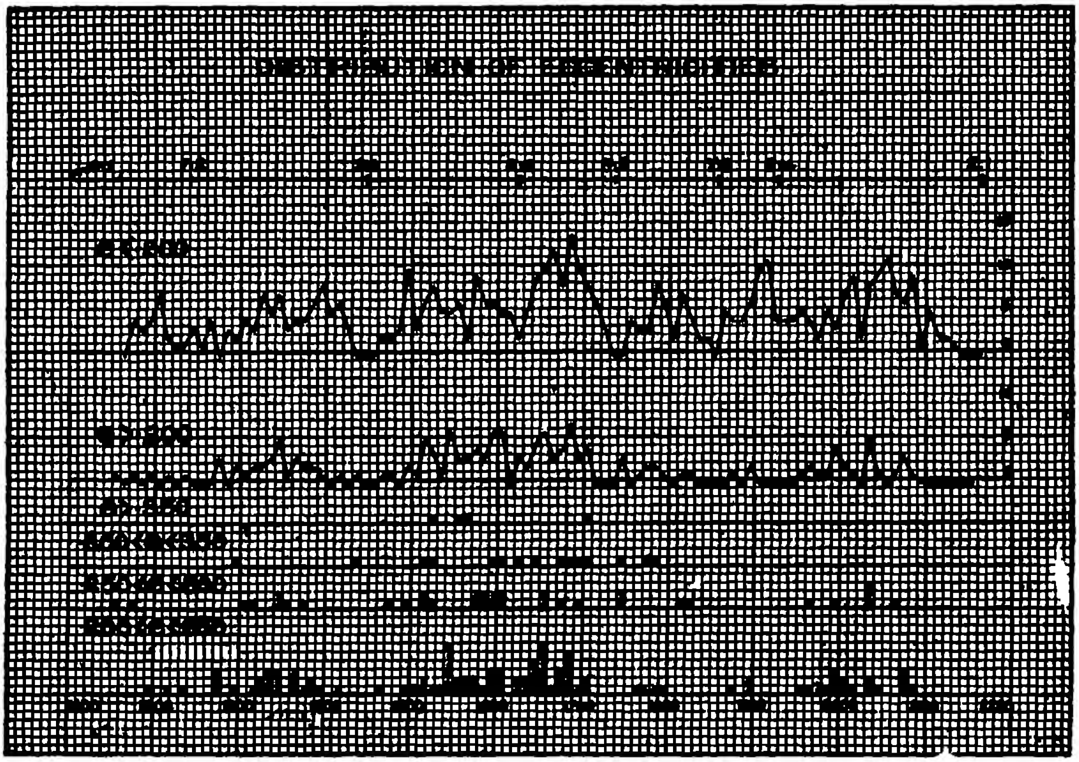

Fig. 3

holds that larger eccentricities are more likely to be absent very close to the gaps than smaller ones.

Referring again to the chart of the general distribution of the eccentricities (Fig. 3), we notice that no one of the ratios, even when the difference of the two terms is 5 (corresponding to a libration with a coefficient depending on the fifth power of the eccentricity), has a close asteroid with

The application of the theory to the satellites and rings of Saturn, though not within the title of my address, can not well be passed over It is now known that the mean periods of the revolutions of Titan and Hyperion round Saturn are exactly in the ratio of 4:3 and that the actual periods librate about this ratio The case is quite similar to that of a ratio 2:1. But here the relative disturbing force is much

smaller and the variations of the eccentricity due to this libration are also much smaller There is, in consequence, less tendency toward instability due to this cause and in fact the numbers do not indicate such a phenomenon The eccentricity does not rise very greatly in value

The divisions of the ring system admit of an explanation if we suppose them to consist of clouds of small bodies subject mainly to the attraction of Saturn and of its satellites A body on or near a critical radius will experience considerable variations of eccentricity which are of long period A narrow ring of these bodies will therefore be moving in ellipses of different eccentricities which vary for the different bodies much more than for bodies not near this ring Hence the range of distance of the bodies composing the narrow ring will be spread out much more than for other rings of the same width. At any given time the number of large eccentricities will on the average be much greater than the number of small eccentricities. On both accounts the number of bodies visible at any one time will be least on the critical radius, rise to a maximum on each side of this radius, and then diminish to the average distribution Thus we get a ring darker than the average between two rings brighter than the average—a result which tends by contrast to increase the apparent difference in illumination

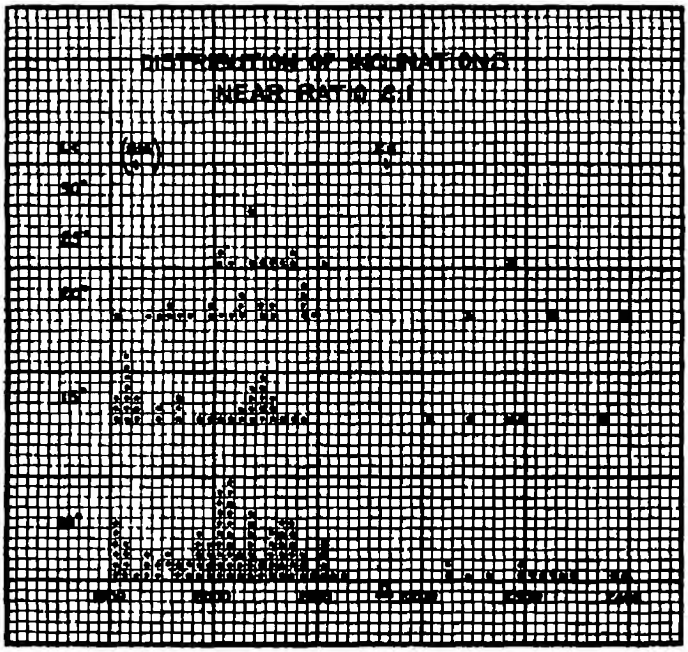

Fig 4

Another result of this variation of eccentricity may be mentioned. Observation shows that the apparent form of the rings is very nearly circular It would seem that the orbits of the separate bodies must have small eccentricities in order to avoid collisions in which the velocities differ considerably. Near a libration region the eccentricities can not remain very small. In the course of long periods of time it would result from this that encounters have taken place which changed the velocities of the

colliding masses sufficiently to cause them to pass away from the region of libration Such collisions may affect the motion in two ways. They may increase the extent of the libration so that the body passes outside of the limits within which librations are possible, or they may at the time diminish the extent of the librations so far that the lower limit of the eccentricity at which librations can be maintained is reached In either case the body escapes from the region of libration and describes an orbit at an altered mean distance and with a period whose difference from the exact ratio never becomes zero Thus while the apparent divisions of the ring are not directly caused by the instability of the librations, they are partly caused by perturbations of large amplitude and perhaps also by the results of collisions arising from those large perturbations.

I have hitherto spoken of the effect of Jupiter's attraction on certain groups of the asteroids A little space must be devoted to the phenomena which are caused in the distribution of the perihelia and nodes of the approximate ellipses in which the asteroids move

When the orbits of but fifty of the asteroids were known it was noticed that the positions of their perihelia tended to group themselves round the perihelion of Jupiter. A similar phenomenon appeared, though not in so marked a degree, with their nodes and the node of Jupiter Newcomb proved that the groupings were consequences of the attraction of Jupiter. His explanation, briefly stated, amounts to this Jupiter causes the perihelia of the asteroids to revolve very slowly round the sun; some of them will librate about the perihelion of Jupiter. In the former case the rates of motion of the lines which join them to the sun are least when these lines are crossing the perihelion of Jupiter, and most rapid when crossing the aphelion of Jupiter Hence at any given time we are likely to observe more asteroids whose perihelia are near that of Jupiter than asteroids whose perihelia are in other positions Asteroids whose perihelia librate must be comparatively few in number. The variations of the eccentricity follow the same law With the nodes and inclinations the effect is less marked In the latest published investigation by von Brunn, who followed Newcomb's methods with 400 bodies, the explanation is confirmed The chart (Fig. 5) which is before you on the screen shows the extent of the variations It is formed with 630 asteroids The points joined by a continuous curve represent the numbers of asteroids whose perihelia lie in the twelve divisions into which the whole circumference has been divided The points joined by a dotted line represent the average eccentricity of those asteroids whose perihelia lie in the corresponding divisions Below are placed the letters *J*, *M*, *E*, *S*, representing the positions of the perihelia, and the letters *J'*, *M'*, *E'*, *S'*, representing the positions of the aphelia of the planets Jupiter, Mars, the earth and Saturn The two upper charts show the results for the first 300 and the last 330 discoveries, and the lower chart the whole 630 The effect of Jupiter is quite clear The traces of the other planets are doubtful. It is true that there is a distinct minimum of the perihelia at the group 10 which contains the aphelia of Saturn and the earth and that it is present in all three charts But there is no corresponding rise at the perihelia, or at any rate the rise is doubtful.

The features of the distribution which are the same in the earlier and later discovered planets can, without much danger of error, be laid aside as consequences of the attractions of the sun and planets.

But there are certain differences which call for special notice. The minima of the perihelia and eccentricity which occurs in the group 7 with the first 300 asteroids occurs in should, of course, be diminished by one eleventh of its height, for strict comparison with the first chart, on account of the total numbers of planets used, but this does not

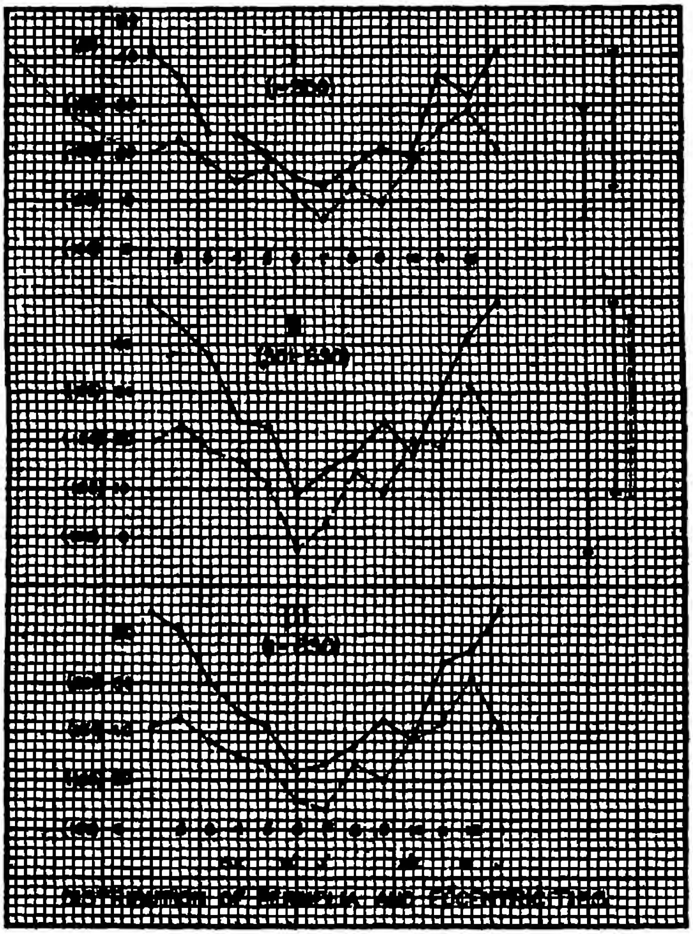

FIG. 5

the group 6 with the last 330 asteroids; the displacement does not appear to be accidental But the most remarkable difference is the greater range between maximum and minimum with the later discovered and presumably smaller bodies with the earlier ones, this difference is observable in both the perihelia and eccentricity curves. Each ordinate of the curve which represents the perihelia in the second chart materially affect the observation The range is greater by nearly 50 per cent. for the perihelia and by nearly 80 per cent. for the eccentricities. Is this a relic of the initial conditions or the effect of some force other than gravitation, for example, light pressure or the impact of material particles entering or leaving the solar system, in which the mass of the asteroids affected will play some part? There is here a wide

field for speculation which I shall not attempt to enter this afternoon.

I have hitherto spoken of asteroids which belong to the main group. Others are scattered either singly or in small groups at quite different distances from the sun Eros, whose orbit lies within that of Mars, is so well known owing to its value for the determination of the parallax of the sun, that it needs only a passing mention. A small group of five asteroids just inside the mean radius at which the period is two thirds that of Jupiter, is of interest as an illustration of the features of those asteroids the large perturbations of which depend on the first power of the eccentricity As at the place where the ratio is 2 1, the planets are on the inner side of the gap It is, of course, not possible to draw any conclusions from so small a number

But the most remarkable illustrations of the problem of three bodies are four small asteroids which have been found within the last five years Before that time the period and therefore the mean distance from the sun of every known asteroid were less than those of Jupiter In February, 1906, Wolf observed a body whose velocity appeared to be unusually small and, in the course of a few observations, it was seen that its orbit could not be very distant from that of Jupiter. Charlier suggested that it might probably be an illustration of one of the two cases in which the problem of three bodies can be solved without approximation. Long ago Laplace proved that if three bodies be placed at the corners of an equilateral triangle and started revolving round their common center of mass with a properly adjusted angular velocity, they would continue to do so indefinitely. The triangle remains equilateral and each body describes an ellipse with the center of mass as a common focus. Further, it has been proved that, provided the masses satisfy certain relations, the motions are stable, that is, small oscillations about the triangular positions would not involve the ultimate loss of the type of motion, the triangle would always remain nearly equilateral As the mass of the asteroid is so small that it may be neglected, the condition for the stability of small deviations is that one mass shall be at least twenty-five times the other, since the sun is over 1,000 times as heavy as Jupiter the condition is well satisfied There seems to be no doubt that the theory is a correct explanation of the facts In the intervening years three more asteroids with similar orbits have been discovered Of the four now known, three are near the point 60° in advance of Jupiter, and one is near the point 60° behind The mean distances of all four from the sun differ but little from that of Jupiter.

If we examine the orbits of these asteroids on the hypothesis mentioned, namely, that they are merely deviations from the triangular solutions, we have to admit at once that the deviations can not be considered very small One of them may move as far as 17° away from the mean position as seen from the sun, and a question naturally arises as to the permanent stability of such large deviations The periods of the oscillations must be very long, not less than 150 years, so that we can not hope to settle the question by direct observation.

These oscillations may be regarded as librational. Bodies well beyond the orbit of Jupiter will revolve around the sun more slowly than that planet, those inside more quickly, and between the two we get a region in which the mean period may be the same. There may then be librations about this mean period which carry the body first inside and then outside the orbit of Jupiter. Referring back to what has

been said concerning the stability of librations around the ratio 2·1, we might be tempted to conclude that the stability of these new asteroids would be still more doubtful This is not so When the mean period is the same as that of Jupiter, the librations are very nearly independent of the eccentricity and inclination unless these are very large, and conversely, the latter are but little dependent on the librations of the mean period It is the only case in which this independence occurs The conditions governing these librations are so different that a separate investigation of them is necessary. I had hoped to lay before you the results which I have so far reached in determining the possible motions of asteroids which circulate with the same mean period as Jupiter In order to do so it would be necessary to exceed greatly the time allotted to me I must content myself with the remark that much larger deviations from the triangular positions appear to be possible and that these may become so extended that a single asteroid may go round both triangular points, passing from one to the other on the opposite side of the sun from Jupiter, and yet not at any time approach very closely to the planet While describing such an orbit the distance of the asteroid from the sun would vary but little

In conclusion, a few words must be said concerning the present condition of the observational material and its future needs. There are about 680 bodies whose orbits are more or less well defined. We have seen that the distribution is by no means uniform With the number on hand we have perhaps sufficient material to determine the general law which governs the arrangement of the orbits This law is, however, only one of the problems which the system presents The student of celestial mechanics needs more asteroids in special regions Reference has been made to the abundance of known orbits on the inner side of the gap which corresponds to twice the period of Jupiter and the lack of material on the outer side Every asteroid added to those very near the gap will be welcome, but there is a real need for more on the outer side In any case new bodies whose periods are close to this ratio should be observed until the eccentricity and inclination can be obtained with moderate accuracy In the course of the search it is possible that one may be found which is within the narrow limits of stability (if the distance between these limits is not zero) of libration At every opposition a few observations of all the known asteroids near the gap should be made, so that the orbits may be verified and the long period terms compared with theory. It will perhaps be advisable to limit the number of asteroids chosen for continuous observation If so, a selection can be made which will give types of small, moderate and large inclinations and eccentricities

A reference to the general chart of distribution of the mean periods will indicate what observational material is needed at the other gaps Aside from the asteroids whose periods have the features which I have just described, every new discovery of a very large eccentricity of inclination should be retained. I would suggest that eccentricities above three tenths or inclinations to the orbit of Jupiter above 20° would perhaps not unduly tax the capacity of those observers who have made and are making valuable additions to our store of knowledge of these bodies.

Finally every asteroid whose period indicates that it is outside the main stream or near its edges should not be lost. More particularly the search might be directed towards the discovery of bodies having the same mean distance as Jupiter, but with

librations more extended than those of the four at present known. As such bodies are moving most slowly when farthest from the triangular points the search would have greater chances of success within twenty-three degrees to thirty-five degrees of Jupiter on either side, or nearly in opposition to Jupiter These three areas are nearest to the earth at different times of the year

Another practical problem is presented by the computation of the orbits This is mainly a matter of expense so far as the ordinary asteroid is concerned, and one way of meeting the difficulty was shown by Watson, who endowed those discovered by himself We need not, however, demand that explorers should be responsible for looking after their own discoveries The asteroids of each type of motion form a group which it would be most economical to treat together if at any time a fund were obtained for the development of the problem. For the present, ephemerides sufficient to identify each body will serve When a reasonable number of accurate observations, extending over a considerable period of time, has been obtained, the comparison of the observations with theory will be of interest to students of celestial mechanics, and the rest of the work will take care of itself

In particular, the Trojan group revolving at the same mean distance as Jupiter and at present consisting of the four bodies, Hector, Achilles, Patroclus and one as yet unnamed, will not suffer from neglect They appear to show one, perhaps the main, stage of transition from bodies superior to the orbit of Jupiter to those inferior to that planet and possibly to those which have become his satellites Their separate paths of motion are interesting to the mathematician, but even more so to the astronomer, since they appear to indicate a new set of periodic orbits in the problem of three bodies The remarkable series of families of such orbits obtained by Sir George Darwin has shown how far such an investigation may lead A single family may have several types Those which I have described appear to belong to perhaps two families at the most, but nevertheless the extent of the work necessary to discuss them is very considerable, and the mathematical portion of it is by no means simple They may be peculiar to systems like our own The work of Sir George Darwin will doubtless have applications to multiple systems of stars, the observational material of which is being rapidly gathered by means of the spectroscope, the heliometer and photographic plate

Theories as to the mode of formation and development of our solar system will, I believe, receive some assistance from these orbits of transition If I have not touched on such questions it is not because the temptation to do so was not present Such matters, however, require an extended discussion under various hypotheses As Brodetski has shown, different hypotheses concerning the nature of possible resisting media lead to quite different results My main object has been to attempt to set forth certain actual and possible types of motion within our solar system at the present time in such a manner as to indicate in what direction the theorist and the observer can best act in cooperation The observer, now that the mass of accumulating material threatens to become too great for permanent record, needs assistance from the theorist so that he may direct his energies into the most useful channels, and not less does the theorist need the help of the observer so that his results may receive confirmation and that he may obtain suggestions for future investigations.

ERNEST W. BROWN

ORGANIC RESPONSE[1]

Recent events in the field of evolution comprehend a number of movements and accomplishments of extraordinary interest. The rediscovery of the facts of alternative inheritance, the formulation of the concepts of equivalent, balanced, paired or differential characters, the results of statistical studies of variability, the analyses of species of various constitution by pedigree cultures, in which the value of fertilization from various sources is carefully measured, the distinction of the biotype or genotype as a hereditary entity, the recognition of the possibilities in the action of pure lines within a specific group, the cytological contributions of fact and forecast upon the physical aspects of heredity, and lastly the presentation of the facts and allowable generalizations identified with the mutation theory, comprise a series of advances, of accretions to knowledge, furnish a broadened foundation for biological science and disclose additional possibilities in all lines of experimental research with living things, besides opening up new realms for speculative thought and stimulating the scientific imagination to renewed fruitfulness

The pressure of undisciplined evidence bearing upon almost all phases of evolution has awakened a freshened chorus of voices crying the virtues of special interests and extolling the sufficiency of theories dignified by age and more or less weighty with authority Those busy with vitalism of various patterns have spun a moiety to mend the breaks in the fragile web of their gossamer tissue made by the impact of new facts Isolation and geographical distribution have again been elaborated to account for all differentiation and what their exponents are pleased to term speciation. The anticipatory formation of structures in a rudimentary condition with a long prefunctional progress, guided by the morphological possibilities and actuated by internal impulses, has again been offered to us, fortified by some facts and much clever logic, in such manner as to avoid most of the serious objections offered, except those of physiological morphology

Natural selection with diverse meanings and manifold implications, has been made to explain development, differentiation and general evolutionary progress, and the tumult is still great about the idea of mutation. Undeniable occurrences of saltatory changes in hereditary lines are numerous and well known, yet it is probable that the importance of mutation as a general procedure varies in different groups of organisms and certain that many shades of opinion as to its exact part in the evolution of living things will always be held

The situation with regard to the theory which predicates direct adjustment of the organism, quickly or slowly, as the case may be, to environic factors, and the full inheritance of the alterations constituting such variations is far more serious The various corollaries of this theory have the force of a certain obviousness, its assumptions have been of ready service to the systematist and biogeographer, and its conclusions have long been tolerated in the absence of decisive tests which are not to be easily made or readily carried out. The time has now arrived, however, when the claimants for Neo-Lamarckianism and all of its conclusions must show cause for its further consideration, or else allow it to drop from the position of being seriously taken as a possible method of evolutionary advance. That no subject is the center of a wider interest is amply demonstrated by

[1] Abstract of presidential address, Society of American Naturalists, Ithaca, New York, December 29, 1910 For full text see *American Naturalist* for January, 1911

the numbers of recent contributions which may be cited. The positive advance implied is so marked as to justify this discussion within two years of the time when the entire matter was presented comprehensively in connection with the various Darwin anniversary programs.

It is unanimously agreed that organisms, plants as well as animals, change individually in aspect, in form and structure of organs, in functionation and habit as they encounter swamps, saline areas, gravelly uplands or slopes, climatic differences identifiable with latitude or elevation, and other physical and biological factors It is assumed that these somatic alterations are accommodative and adaptive, making the organism more suitable for the conditions which produce the changes. Such an assumption is an over-reaching one Any analysis of the changes which an organism undergoes after transportation to a new habitat will disclose one, or a few alterations which might be of advantage in dealing with the newly encountered conditions, but with these are many others, direct, necessitous, atrophic or hypertrophic as to organs which have no relation whatever to usefulness or fitness. Further, a critical examination fails to disclose any theoretical considerations or any actual facts which would connect inevitably the somatic response with the nature of the excitation, outside of the specialized tropisms in which specific reactions are displayed. Even in these the adjustment is of such nature that a mechanism specially responsive to contact, tendrils, for example, responds in the same manner to temperature variations, to which the movements are in no sense accommodations or adjustments.

With regard to the more obvious and direct responses of organisms to altered environment, the records of the operations of the horticulturist, the agriculturist and the breeder as to the behavior of crops, plants and domestic animals, when transferred from one habitat to another, are rich in information. The greater part of such data is the result of observations which do not comply with the ordinary requirements in the avoidance of error so that strict comparisons as to the behavior of organisms under the conditions of various habitats are impossible, but the literature yields many suggestions for experimental research, and the simple generalization that the direct effects of climatic complexes on the seasonal cycle, and upon color, or structural features of the individual, may be repeated or carried over two or three generations, in a habitat where the specific causal combinations are lacking.

Although organized with due regard to the requirements of strict experimentation, the lowland and alpine cultures of plants by Nageli and Bonnier offer us nothing more decisive than the above Likewise many experiments dealing with the responses of organisms to selected agencies have obtained nothing but negative results, even when artificial selection was employed to accentuate or perpetuate the feature constituting the reaction

Buchanan working with *Streptococcus lacticus* finds that phases of fluctuating variations of certain features induced by external exciting agencies may not be fixed and are not transmissible. Jennings' cultures of paramœcia were carried through hundreds of generations with no progressive action in fluctuating variability, while the organism, as a whole, was strongly resistant to all kinds of environic influences: actual alterations were extremely rare. Most of the supposedly acquired characters disappeared in two or three generations by fission.

In the experiments of Sumner mice reared in a warm room were found to differ con-

siderably from those reared in a cold room in the mean length of the tail, foot and ear, and the differences were transmitted to the next generation. The differences may be reasonably designated as being directly individual and somatic, and as having been transmitted by the germ-plasm, which was not subject to the action of various temperatures in the first instance. The reaction forms have an additional claim upon our attention, since they are the ones which distinguish northern and southern races of many animals. The crucial test of the value of the alterations induced in the mice is the one applicable to all of the experimentation on this subject, a test in which two parallel series of cultures, one under the altered environment and the other under usual conditions, should be kept going continuously for a longer series of generations, lots being withdrawn from both, from time to time, for continued comparative culture in normal habitat and under other conditions.

The same considerations apply to Kammerer's experiments with salamanders in which the reproductive habits of *Salamandra atra* and *S. maculosa* were altered to resemble each other by specialized exposure to climatic factors, and while his later work with *Lacerta* has resulted in the production of some extremely striking changes in the color bands which behaved in a Mendelian fashion when paired, yet these have not been followed to the third and fourth generations. The permanency of the induced changes seems highly probable in this case. There is, however, a great body of properly authenticated evidence which demonstrates conclusively that external agencies acting upon bacteria, crustaceans, beetles, fungi and some of the higher types of seed-plants have been seen to result in the appearance of new types or genotypes, which have been found to transmit their characters perfectly through so many generations as to indicate practical permanency.

The names of Beijerinck, Winogradsky, Lepeschkin, Hansen and Barber are associated with records of mutational occurrences in pedigreed strains of yeasts and bacteria under pressure of unusual media or other environic conditions. Some aberrants being propagated by fission and others through the spore stage, some only by selection and others independently. In addition Pringsheim finds many accommodative responses to unusual culture media, temperatures and poisons, which may be cumulated and become fixed in these lower organisms, being transmissible by fission or by spores.

My own earlier work with relation to this subject consisted chiefly of ovarial treatments in which the main and accessory reproductive elements of seed-plants were subjected to the direct action of solutions of various kinds. A new combination of characters constituting a distinct elementary species or genotype was obtained in one plant, and the divergent type has been found to transmit its qualities in the fullest degree, as far as tested, to the fifth generation. Still more marked forms were obtained in a second genus, the divergent progeny being lost in transference to the Desert Laboratory, while distinct responses have been obtained in the extensions of these experiments upon species representing widely different morphological types in Arizona. The greater majority of the tests have been made upon plants growing under natural conditions, so that environmental reaction in addition to that of the specific reagents might be excluded. Progenies representing many species, including thousands of individuals, many of which are divergents, are now under observation. Absolute finality of decision with respect

to the standing of the new types may be reached but slowly.

The important results of Tower, in which new types and various hereditary departures in the Leptinotarsæ were induced by the action of climatic factors on the germ-plasm, have been so fully described and repeatedly cited that any further description is unnecessary at the present time

Gager produced chromosomic irregularities by the exposure of ovaries of *Œnothera* to radium emanations a few years ago and some of the progeny from treated parents were aberrant, but the transmissibility of the new characters was not tested By the use of similar excitations Morgan has recently induced the appearance of white eyes and short wings in the fly, *Drosophila*, which characters seem to be fixed and fully transmissible Both are sex-limited and Mendelize when paired with red eyes and long wings.

Woltereck's cultures of *Daphnia* have yielded some facts of unusual interest in the present connection. The particular group of this crustacean furnishing the experimental material is taken to be very variable, and it was subjected to over-feeding, with the immediate result that the variability of the form of the head appeared to be widened, the size of this structure being increased. This disappeared when lots from the cultures were restored to normal conditions in the earlier stage of the work. After three or four months of over-feeding, the form of the head came within narrower limits, and fewer aberrants were seen, while lots returned to normal conditions, showed a slower restoration of the original form of the head. Two years after the cultures were begun, it was found that the original head form was not displayed by young restored to normal nutrition conditions, the larger helmet being persistent. It seems fairly certain that a new genotype resulted from the long-continued action of the culture medium, which must have influenced the soma and germ-plasm contemporaneously

Klebs, who has long been concerned with the morphogenic reactions of plants, has determined a series of conditions under which stages of mycelial development, asexual, zoospore and sexual or oospore formations in filamentous fungi may be inhibited or variously interchanged Much more important reactions were obtained from *Sempervivum*, the live-forever of the garden In this plant, dense rosettes or propagative bodies are formed at the ends of some branches, and inflorescences were replaced by single flowers by experimental excitation · the number and arrangement of the floral organs as well as of the stamens and carpels could be altered. Furthermore, the deviations in question were found to be transmissible in guarded seed-reproductions

Lastly we now have the fortunate experiences of Zederbauer with *Capsella* which has yielded some conclusions of exceptional importance A genotype of *Capsella bursa pastoris* resembling *taraxacifolium* was found on the lower plains of Asia Minor, and displayed the well-known characters of this form, including broad leaves, whitish flowers, and stems 30–40 cm high. A highway leads to a plateau at an elevation of 2,000 to 2,400 meters, along which the plant has been carried by man, and in this elevated habitat it has taken on certain alpine characters, including elongated roots, xerophytic leaves, stems 2, 5 cm high, reddish flowers, with a noticeable increase of the hairiness of the entire plant. That the distributional history has been correctly apprehended seems entirely confirmed by the fact that when seeds are taken from the lowlands the

alpine characters enumerated are displayed at once as a direct somatic response When seeds are taken from plants on the elevated plateau where their ancestors may have been for many years or many centuries (perhaps as long as 2,000 years) and sowed at Vienna, and at other places, it was found that in four generations the leaves lost their xerophytic forms and structure, but the other characters were retained within the limits of variability The stems showed an increase in average length of 1 to 2 cm, the roots changed as much, but the reproductive branches and floral organs retained their alpine characters The slight modifications undergone by these features were seen to reach a maximum and to decrease in the latest generations cultivated The structural changes and implied functional changes are originally direct somatic responses; there is no escape from the conclusions that the impress of the alpine climate on the soma has been communicated to the germ-plasm in such a manner as to be transmissible, and the suggestion lies near that repeated and continued excitation by climatic factors may have been the essential factor in such fixation.

A related phase of the subject is that of the interposition of environic factors in mutations and hybridizations De Vries appears to have first called attention to the fact that the composition of hybrid progenies of mutants with each other and with the parental form might be altered by nutritive conditions, and the author has described mutants given off by *Œnothera Lamarckiana* in New York which had never been seen in Amsterdam. Furthermore, in discussing the divergent results of De Vries and myself, obtained by crossing the same forms in Amsterdam and New York, the suggestion was made in 1905, that "the manner in which the various qualities in the two parents are grouped in the progeny might be capable of a wide range of variation. Many indications lead to the suggestion that the dominancy and prevalency, latency and recessivity of any character may be more or less influenced by the conditions attendant upon the hybridization, the operative factors might include individual qualities as well as external conditions."

Much more striking evidence upon the matter has been recently obtained by Tower in intercrossing *Leptinotarsa decemlineata, L. multilineata, L. oblongata* and other species in their habitats in southern Mexico, and at the Desert Laboratory. The observations were carried on with both normal and hybrid crosses, in crosses between races which had been built up selectively, and between forms which arose as sports proving conclusively that external agencies may alter the action of paired reproductive elements Kammerer's contribution to this subject consisted in demonstrating that newly induced color characters in *Lacerta* displayed dominances different from those of the original types, while Tennent has proved that the dominances in crosses of *Hipponoe* and *Toxopneustes* variously attributed to seasonal changes, variations in temperature, etc, are in reality to be attributed to the concentration of the OH ions in the sea-water

The first realization of results of importance from cultures widely extended geographically have been obtained in the experiments with Leptinotarsæ by Tower, in which various species of these beetles were studied in their habitats in southern Mexico, in open air and glass houses as far north as Chicago, as far east as the Atlantic and as far west as the Desert Laboratory. Facilities for work upon special problems are now being organized at sev-

eral places and many contributions to the subject may be expected within the next decade.

The plan for work upon the problems of special interest in connection with the Department of Botanical Research of the Carnegie Institution of Washington, implies the establishment of experimental cultures in localities which furnish distinct types of climate or which have characteristic congeries of meteoric factors, as indicated by the vegetation indigenous to them. Secondly, these localities have been chosen with regard to their geographical relations so far as possible, in order that the possible and probable fate of migrating species might be studied. The behavior of plants in these localities is recorded as to anatomical alteration and physiological departure. Having detected some such feature of apparent importance, its reappearance in plants from seeds carried to the original habitat and other locations is followed as one line of evaluation. Contemporaneously, the form is taken into the laboratory and here by analytical experimental tests the effort is made to ascertain to what special agencies the departures are due. Such determination of the identity of exciting agencies has been made by Stockard, who found that the cyclopean embryos of *Fundulus* occurring in nature could be induced by the action of magnesium salts introduced into the sea-water containing the eggs.

Our increased insight into the nature of natural groups of organisms has shown the necessity and suggested the means of observing certain distinctions and precautions in this work. Thus it is of the greatest importance that the living material shall be shown to be either simple genotypes or that its phænotypic nature be apprehended in order that the integration and combination of these forms shall not be mistaken for environic effects. When a lot of plants is taken from one plantation to another, data of the original locality are preserved, as the stand of the plant in that place serves as the control. If the plant is multiplied vegetatively in the test, it might reveal a possible complex character of the material in bud sports, but other divergencies might be well ascribed to local effects. On the other hand, if introduced in the form of seeds, the possible complex character of the material would soon become apparent, especially if the generations were followed properly. In the actual management of the cultures, it is found profitable to reintroduce forms from the original or control lot of various species in order to follow the first stages of their adjustment repeatedly.

The genetic character of environic effects remains to be considered. In any species or genotype there is, withal, a limited number of things included within the morphological possibilities. The appearance of any character in an acclimatization culture raises a question at once as to the standing of the new feature. Is it a regressive character, once displayed by the species and now recalled, or is it to be considered as a character *de novo*, arising simply and directly in response to the external agencies which have been seen to induce it? Thus our general knowledge of the Cactaceæ leads us to assert with some confidence that the reappearance of a full complement of spines in a prickly pear, from which they had all but disappeared, is a regression or return to the condition of the greater majority of the group, a condition which must have been shared by its ancestors at no remote stage in its progressive development.

None of the attempts hitherto made to perfect a theoretical conception which would be useful in interpreting the mech-

anism of environic responses has had anything more than the most limited usefulness. The stimuli of climatic and many other agencies do not imply the introduction of any strange or new substances into the bodies of the organs affected. These agencies might change the dissociations in such manner as to modify the relative number of free ions and thus alter the molecular complex of the living matter in a very important manner however. The intricate play of enzymatic action might also be altered, and any modification of the relative reaction velocities of the more important processes might result in material and permanent change, especially in those cases, in which external agencies interfere directly with the action of the germ-plasm.

The introduction of solutions into ovaries or the exposure of reproductive elements to unusual irradiation may raise the additional liability of disturbed polarity and of modified surface tensions in the cells. It is conceivable that the rearrangement or disturbance of the localizations of substances, especially the mineral salts, might seriously modify the capacities of the bearers of heredity. These direct and material possibilities offer an adequate basis for the organization of experimental research upon the main subject as well as the means of interpretation of results without recourse to schemes of particulate inheritance or theories as to the constitution of germ-plasm to which may be ascribed usefulness in the discussion of other problems in evolution.

The theoretical considerations which might lead us to assign all cases of perpetuation of environic effects to the direct action of the exciting agency upon the germ-plasm are perfectly competent to be questioned with each new bit of evidence brought forward. My own results so far have been all of this kind, as are many of the instances cited, but the case does not appear so simple when, as in *Sempervivum*, somatic alterations are induced late in the ontogeny and are transmitted by seeds borne on the altered branches, and equally serious doubts are raised when one considers the multifold somatic alterations of *Capsella* and the fact that they must be repeated dozens, perhaps hundreds, of times before being transmissible. One must not lose sight of the fact that the soma is itself the most closely interlocking environment of the germ-plasm, and not until the germ-plasm has been exposed to interaction with a changed soma for repeated generations does it undergo the changes necessary to an altered heredity.

The problems of real interest, however, are those which concern the actual influence of environment upon evolutionary development, and with regard to these many generalizations of importance are becoming possible, and their brief summarization may suggest some encouraging advances.

First it is to be seen that not all environic effects induced in the laboratory or by transplantations are heritable, although they may be carried over for two or three generations. No satisfactory basis has yet been found upon which it might be predicted that any effect would be ephemeral or permanent. The characters induced in an hereditary line may be regressive, or awakened latencies or organizations *de novo*. The alterations which become permanent may be cumulative in construction, although they are mutative or abrupt in their appearance in most instances. Abruptly displayed by some organisms, yet they may not become heritable until the germ-plasm has been repeatedly subjected to the direct action of the exciting agency or to the effect of a changed soma for many generations.

Orthogenetic or heterogenetic as to direc-

tion, they may be consequently accommodative or correlational, incidentally adaptive, or wholly inutile in their functional relations

D. T. MACDOUGAL

EDUCATIONAL AND INDUSTRIAL EFFICIENCY

THE latest bulletin of the Carnegie Foundation has many attractive features. The report has evidently been made up in a spirit of good will to education, and any sting that it may contain should be removed by the admirable introduction by Dr. Pritchett. In the course of more than a hundred and thirty large pages the author, Mr. Cooke, makes a number of excellent suggestions, which are none the less excellent because of their lack of novelty. He is aware that the charge of Philistinism might easily be suggested by the tenor of his remarks and he makes some effort to protect himself accordingly. His peculiar point of view seems to give undue prominence to "the cost per student hour," but although we hear much of this phrase in the report we are distinctly told in one place that "It should be borne in mind that the cost per student-hour has absolutely no value in distinguishing relative educational values." If this had been placed as a headline to all the pages, it would have greatly improved the value of the report, and would have been in harmony with this other admirable sentence which might with equal propriety have been inserted as a foot-note to every page: "In the last analysis the usefulness of a university is the measure of its mental, moral and spiritual product—and product interpreted as broadly as you please."

However, although there is much that is excellent in the report, it has many weaknesses. It is written from the point of view of the man who is used to report on the efficiency of a glue factory or soap works. Whenever it touches the strictly educational field and gets away from the factory the trail of the amateur is over it all. It is full of commonplaces, and there is scarcely a question raised that has not been discussed *ad nauseam* by college professors and other officers. It is not lacking in confidence. One marvels at the temerity even of an "efficiency engineer" who can lay down the law so definitely as to how to teach physics, how to conduct a recitation, how to carry on research, when most of us who have devoted our whole lives to such problems are far less confident. There are, however, here and there some pleasing evidences of diffidence. In discussing the important educational problem of janitor service Mr. Cooke says, "A sharp line should be drawn, *probably*, between the cleaning of the buildings and the care of apparatus." The use of the word "probably" is a master-stroke. It conjures up pleasing pictures of janitors handling the delicate instruments of a physical laboratory just as they furbish the brass plates of a glue factory—if indeed "the snap and vigor of the business administrator" which Mr. Cooke admires so much decree that such things are a necessary adjunct to the dignity of the factory. Almost on a par with this use of "probably" is the statement that "There is a good deal of the feeling that lectures to be good must in a way bear the marks of the inspiration of the moment. But a good many men who have the reputation of being high authorities assured me that the carefully thought out plan for a series of lectures would win out every time over the inspiration of the moment idea." Of course they assured Mr. Cooke of this, but they must have smiled at the naiveté of the question and wondered who ever suggested that the presentation of a scientific subject be left "to the inspiration of the moment."

The report shows many evidences of ignorance of the history of education. It suggests as novelties plans that have been tried for centuries and abandoned only after careful consideration. Such, for example, is the suggestion that the rules for the conduct of the students and the punishments for their breach should be put into precise form. The collection of such rules from the archives of the older universities would fill many volumes. Again he says, "It may turn out that ultimately the matter of examinations will be handled by an agency outside of the depart-

ment." This, to his vision, is a far-off divine event to which the whole educational creation is moving If so, it is moving backwards.

Mr Cooke's remarks on the economic use of rooms and buildings are, for the most part, eminently sensible, although he contributes nothing new to the discussion of a very old problem His economic sense is shocked on learning that a lecture room in the department of physics is used only four hours a day, just as it must be shocked when a church is used only a few hours a week, or a life belt only when it is actually needed In some of his criticisms under this heading he seems to forget that colleges have to make the best of the materials that are available and that in many cases an apparently uneconomic use of rooms is forced upon them because their buildings are old, or were designed for other purposes than those to which they have now to be put. He commends one institution for a space-saving device and wonders that it is not adopted in all departments, the fact being that the newer buildings were designed for its use, but the older ones were so constructed that its adoption there would not have been a real economy.

Mr Cooke displays unusual weakness when he takes up the subject of research. Indeed most of what he says on this subject must be received with that mixture of astonishment and embarrassment with which we listen to the words of a distinguished friend who pronounces an absurd judgment on an important subject that he has evidently not mastered Listen to this: "I believe there is a distinct disadvantage to undergraduate students to be near research work I think in the case of physics research workers, their good *influence is more often offset by the introduction into the undergraduate laboratories of the necessarily deliberate and experimental methods of the research laboratory*"!! How unfortunate if "deliberation" and the "experimental method" should contaminate the laboratories—it might detract from the "snap and vigor" of these promising undergraduates. And yet one wonders what possible use there can be in teaching physics at all, if so much care is to be taken to guard the students from catching its spirit and grasping its method. We, in our ignorance, had imagined that the method and the spirit of science were its very essence, especially where undergraduate learning is concerned. We should have accounted any system of education that failed to recognize this as but so much dross and dung (if, at this season, a Scriptural phrase may be permitted) even if it resulted in every undergraduate gaining 100 per cent. in the examinations conducted by Mr. Cooke's "bureau of inspection"

Perhaps enough has been said to indicate that there are serious blemishes in this bulletin. If, however, it be taken for just what it is worth, it can do no harm and may do much good We should regard as a friend every one who helps us to improve our methods and if this report enables us to keep our accounts better, or make a more economical use of our machinery, of course it will be heartily welcomed. The most serious objection that I see to it lies in its abuse rather than its legitimate use I fear that it will tend to increase the administrative machinery of our educational institutions, machinery that is already far too much in evidence. When one listens to all the criticism of our colleges and thinks of the great things that have been accomplished elsewhere with so little machinery and so little noise, one wonders whether it might not be better for us also to settle down to quiet work. Then I confess that all this talk of "cost per student hour" strains my patience to the limit, especially when it is presented under the heading "gauge of efficiency." Mr Cooke frankly recognizes its usefulness to this end, but others may be led astray by the specious analogy with the workings of a factory. A college that had reached the acme of perfection as gauged by Mr. Cooke's standards might be highly inefficient as an instrument of real education. Mr. Cooke tells us that in studying the colleges he has constantly held in mind "the equivalent mechanism" used in the industrial world and apparently he looks forward with pious expectation to the day

when our colleges will run with the uniformity of looms in a mill. Granting with Mr Cooke that there is much that the administrators may learn from the mill manager, it is to be hoped that enlightened public opinion will never permit us to forget that in all matters that are really vital to education there is no "equivalent mechanism" in the industrial world. We are not making shoes or bricks or cloth, but are dealing with material of the utmost complexity and variety, with no two specimens quite the same and no two that need just the same treatment Uniformity in the product is not only unattainable, it is not even desirable, and factory methods are entirely out of place. If we neglect the human factors in our education we are lost and we can not overlook the fact that, without such bulletins as this, there are already plenty of forces at work to give sufficient prominence to mechanical conceptions and mechanical tests. Nor does it require any special effort in this country to stimulate admiration for the "snap and vigor of the business administrator," while the value of snap in the domain of education may very easily be overestimated. Especially am I fearful of its effect on the teacher and the investigator. His path is not too smooth already and even now there are many forces drawing him from the educational sphere where best he can serve society Think for a moment of the effect on men like Newton or Faraday of the "snap and vigor" treatment that Mr. Cooke suggests in his discussion of research. They must make frequent reports on the progress of their research and constantly justify the expenditure thereon. The superintendent of buildings and grounds, or other competent authority, calls upon Mr. Newton.

Supt. Your theory of gravitation is hanging fire unduly The director insists on a finished report, filed in his office by 9 A.M. Monday next; summarized on one page; type-written, and the main points underlined. Also a careful estimate of the cost of the research per student hour.

Newton. But there is one difficulty that has been puzzling me for fourteen years, and I am not quite . . .

Supt. (with snap and vigor) Guess you had better overcome that difficulty by Monday morning or quit

R. C. MACLAURIN

MASSACHUSETTS INSTITUTE OF TECHNOLOGY
December 24, 1910

SCIENTIFIC NOTES AND NEWS

AT the recent annual meeting of the American Anthropological Association, held in Providence, R I, officers were elected as follows. *President,* Dr J Walter Fewkes, Washington, D C., *Secretary,* Dr. George Grant MacCurdy, New Haven, Conn , *Treasurer,* Mr. B. T B. Hyde, New York, and *Editor,* Dr John R. Swanton, Washington, D. C.

THE following officers of the American Fern Society were recently elected for 1911: *President,* Dr. Philip Dowell, Port Richmond, N. Y., *Vice-president,* Miss Nellie Mirick, Oneida, N Y; *Treasurer,* Mr. Harold G Rugg, Hanover, N. H; *Secretary,* Mr. L. S. Hopkins, M A, Pittsburgh, Pa.

ON December 20 the Paris Académie de médecine held its annual election, Professor Lannelongue, the vice-president, assuming the presidency and Dr. Gariel, professor of medical physiology at the Paris Medical School, being elected vice-president.

LORD AVEBURY has been elected a corresponding member of the Paris Academy of Sciences, in the section of anatomy and zoology.

THE section of chemistry of the Royal Academy of Science of Stockholm has elected Mme. Curie a foreign member in place of the late Professor Cannizzaro.

MR. ERNST LEITZ has received from the University of Marburg the honorary degree of doctor of philosophy on account of his services to science in having constructed for over fifty years instruments of scientific value.

A 450-acre forest reserve in Vermont has been named the "L. R. Jones State Forest" in recognition of the services of Lewis R. Jones, for twenty years associated with the

University of Vermont as professor of botany, and now professor of plant pathology in the University of Wisconsin.

PROFESSOR C V PIPER, of the U S Department of Agriculture, sailed from San Francisco on January 7 for Manila. He goes to the Philippine Islands primarily to investigate the possibilities of growing hay there suitable for horse feed Before his return he will make extensive investigations of forage crops in India

PROFESSOR CHARLES I CORP, assistant professor of mechanical engineering at the University of Kansas, has gone to the University of Wisconsin to do a year's research work in the hydraulic laboratory.

UNDER the auspices of the Harrison foundation, Dr Arthur Gordon Webster, professor of physics in Clark University, will deliver at the University of Pennsylvania a series of lectures on "Sound in Speech and Music. Its Production, Reproduction, Transmission and Measurement"

PROFESSOR CHARLES E MONROE, of George Washington University, read before the American Philosophical Society, on January 6, a paper on "The Investigation of Explosives at the Pittsburgh Testing Station"

A STATED meeting of the Geographic Society of Chicago was held on January 13, when a lecture was given by Professor Charles K. Leith, of the University of Wisconsin, on the subject "A Summer on Hudson Bay." A reception followed the lecture

DR. FRANCIS GANO BENEDICT, director of the Nutrition Laboratory of the Carnegie Institution, formerly professor of chemistry at Wesleyan University, gave an illustrated lecture on "The Influence of Mental and Muscular Work on Nutritive Processes" before the Middletown Scientific Association on January 10.

ON the evening of January 9, at the Brooklyn Institute of Arts and Sciences, Dr. Edwin F. Northrup, of Princeton University, delivered a lecture entitled, "New Devices for Electrical Measurements." The lecture was illustrated with lantern slides and a collection of instruments for precision measurements in electricity.

AT the fifth annual meeting of the American Society of Biological Chemists held in New Haven, Conn, December 28–30, 1910, the following resolutions were adopted by the society concerning the recent death of Dr Christian A. Herter, one of its charter members:

Resolved, that in the recent death of Dr Christian A Herter, the members of the American Society of Biological Chemists, assembled at New Haven for the annual meeting of the society, desire to express their sorrow at the loss of an eminent colleague and their appreciation of the services rendered by him to the science which the society represents By his own work, by the inspiration, encouragement and support which he so freely gave to others, he rendered inestimable service to the advancement of biological chemistry, and especially in its relation to the problems of practical medicine His kindness of heart and his sympathetic interest in the work of his associates, coupled with modesty regarding his own achievements endeared him to all who came in personal contact with him The spirit which animated his life and which guided his actions in the direction of service to others is expressed in material foundations which he has left for acquiring and diffusing knowledge The same spirit is expressed in the influence he has exerted on the lives of his associates

Resolved, that as a tribute to the memory of our late associate, these resolutions be inscribed on the permanent records of the society and a copy sent to his bereaved family

(Signed) RUSSELL H CHITTENDEN
JOHN J ABEL
A N RICHARDS
Committee

THE American Breeders' Association will meet at Columbus, Ohio, from February 1 to 3, under the presidency of secretary James Wilson.

WE learn from the London *Times* that the new "Institut de Paléontologie Humaine," which Prince Albert of Monaco has promised to found in Paris, is to be placed under the patronage of the state. It will be administered by a council of six members, who are to

be of French nationality, and who will be assisted by a committee of French and foreign authorities. The new foundation will be installed in a building of its own which is to be erected in Paris, and in addition to a capital of over $300,000 the institute will be presented with the Monaco collections.

THE five academies of the French Institute held their quarterly plenary sitting on January 5, when the meeting discussed the question of the eligibility of women candidates for the institute The motion in favor of the admission of women, which was prompted by the candidature of Mme Curie for one of the vacant seats in the Academy of Sciences, was rejected by 90 votes to 52 A resolution was adopted in which it was declared that, although the institute did not pretend to dictate to the separate academies, there was an "immutable tradition" against the election of women, which it seemed eminently wise to respect

THERE has been presented to the American Museum of Natural History and placed on exhibition in the Morgan-Tiffany Gem Room a specimen of the new gem Morganite (rose beryl) It is a long oval stone of rich rose color and weighs 57½ carats This gem was named by Dr George F Kunz, the honorary curator of gems of the American Museum, at a meeting of the New York Academy of Sciences on December 3, 1910

ACCORDING to the London *Times* the German Antarctic expedition, under the command of the Bavarian explorer, Lieutenant Filchner, will leave Germany early this year for Buenos Aires, and will proceed from there at the beginning of October *via* South Georgia and the Sandwich Islands to the Weddell Sea The route has been chosen so as to allow of oceanographical research on the way. On arrival in the Weddell Sea it is proposed to establish a base station on the eastern coast as far south as possible, with the necessary equipment for a year's research. A party of ten men will be landed, of whom six—a geologist, a meteorologist, an astronomer, a doctor who is also a biologist, a cook and a sailor—will stay in the station, while the remaining four will undertake a long sledge expedition into the interior of the South Polar continent. Meanwhile the ship will return to the Atlantic Ocean to carry out coastal observations and oceanographical work.

A LETTER from Professor Frost received at the Harvard College Observatory states that Nova Lacertæ was observed at the Yerkes Observatory on December 31, 1910, and January 2 and 3, 1911 An excellent photograph of the spectrum was obtained by Frost with the 40-inch telescope which showed that the spectrum closely resembled that of Nova Aurigæ and Nova Persei, No 2 The position of the Nova for 1911 0 was determined by Professor Barnard as follows· R A. $22^h 32^m 11^s 79$, Dec $+52° 15' 19'' 8$ A star in the exact position of the Nova, of about magnitude 14 0, was found on plates made on August 7, 1907, August 22, 1909, and August 24, 1909 From a photograph made with the 24-inch reflector, Parkhurst and Slocum suspect nebulosity about the Nova, and find the photographic magnitude on January 2 and 3 to be 7 12 and 7 21 Professor Campbell writes that very satisfactory observations of the Nova were obtained at the Lick Observatory on December 31 and January 1 and 2

THE Berlin correspondent of the *Journal* of the American Medical Association writes that on December 10 a mausoleum for Robert Koch was opened in the institute for infectious diseases of which he was director for many years It was formed from some rooms of the institute The funds for the rebuilding, amounting to about $5,000, were contributed by his many pupils and friends The mausoleum consists of two rooms, the first a small antechamber in which some of the scientific instruments used by Koch, his numerous domestic and foreign honorary diplomas, models of the medals awarded to him and other memorials of his life are placed. Here also is the so-called "golden book" of the Robert Koch Foundation for the War on Tuberculosis that contains in an artistic setting the history of the foundation and the autographs of the larger contributors to the fund. In the

special memorial hall, in a niche that is closed with a white marble slab, is placed the urn that contains the ashes of Robert Koch. The walls and floors are all of marble Over the niche for the urn is a marble tablet on which is a portrait of Koch in relief, larger than life size, and on the opposite wall the chief dates of Koch's life are engraved On December 11 the special memorial service took place in the new hall of the university. The large hall which seats about 1,500 persons was filled with a mourning throng which included many physicians, especially members of the Berlin medical faculty, representatives of the government and the chief German medical faculties and representatives of many medical societies as well as of foreign universities and societies. The memorial address was delivered by Professor Gaffky, who was for many years a pupil of Koch and is his successor as director of the institute for infectious diseases.

UNIVERSITY AND EDUCATIONAL NEWS

The report of the tax appraiser on the Kennedy estate has now been published, showing that the bequests for educational and public purposes are even larger than had been anticipated Columbia University receives $2,358,000, New York University $952,000 and Robert College, Constantinople, $1,800,000; the bequests to the New York Public Library and the Metropolitan Museum of Art are in the neighborhood of $2,800,000. Barnard College and Teachers College, Columbia University, each receive $100,000, as do Hamilton College, Elmira College, Amherst College, Williams College, Bowdoin College, Yale University, Tuskegee Institute and the Hampton Institute Lafayette College, Oberlin College, Wellesley College, Berea College and Anatolia (Turkey) each receive $50,000 The bequest to hospitals and to the boards of the Presbyterian Church are very large.

Mr. Carnegie's latest gift of $3,800,000 to the Technical Institute in Pittsburgh is to be used approximately as follows: $2,300,000 for increase of present endowment, $1,375,000 for new buildings, $100,000 for additional equipment and $25,000 on grounds.

The residue of his estate, valued formally at "not more than $50,000," is divided between Yale and the University of Leipzig by the will of Dr. Albert Seesel, a New York physician. With the income there is to be founded at each institution the "Theresa Seesel Fund" in memory of his mother, to be used for researches in biology.

A lectureship on the history and institutions of the United States has been established at Oxford, to be held by American scholars The subject matter of the lectureship is to be the political, institutional, economic or social history or conditions of the United States.

The trustees of the University College of Medicine, Richmond, Va., have awarded contracts for a new college building, to cost $135,000, to replace the one recently burned.

The University of Cincinnati sent as delegates to the meeting of the Ohio College Association and the Ohio Association of Medical Teachers at Columbus during the Christmas vacation, President Dabney, Dean Woolley, of the Medical School, and Professor Jones. President Dabney presented a resolution which was unanimously adopted, asking the Board of Medical Examiners of Ohio and the Ohio Medical Association to join with the Ohio College Association in memorializing the legislature to advance the standard for entrance to the medical colleges in Ohio, by requiring that the entering student shall have done two years of college work, including in this work chemistry, physics, biology (each of these with laboratory courses) and modern languages. The Medical College of the University of Cincinnati has already adopted this standard.

Dr. W. H. Howell has resigned as dean of the Johns Hopkins Medical School, and has been succeeded by Dr. J. Whitridge Williams.

Dr. Josiah H. Penniman, professor of English and formerly dean of the college department of the University of Pennsylvania, has been chosen vice provost

Dr. David L. Edsall, professor of medicine in the University of Pennsylvania, has

accepted a professorship of preventive medicine in Washington University, St Louis.

PROFESSOR GUIGNARD, for fifteen years director of the Paris School of Pharmacy, has resigned his appointment and is succeeded by M. Henry Gautier, professor of mineral chemistry at the school

DISCUSSION AND CORRESPONDENCE

SPECIAL COMMITTEES ON ZOOLOGICAL NOMENCLATURE

TO THE EDITOR OF SCIENCE: The International Commission on Zoological Nomenclature is trying a plan of cooperation with international committees representing the various branches of zoology in an effort to determine in how far it will be possible to reach a unanimous agreement upon the names of the most important zoological genera, together with the type species of the genera in question.

The International Commission of Medical Zoology, established at the Graz Congress, has undertaken a study of over three hundred names applied to the trematodes reported as parasitic in man. This commission is to pass upon the zoological status of the names in respect to synonymy and validity. The report will then be submitted to the International Commission on Nomenclature It is the plan of the latter commission to publish the report, and to invite criticisms upon the same from the zoologists of the world After ample opportunity is given for such criticism it is the plan of the commission on nomenclature to attempt to reach a unanimous ruling upon the names, and to submit this ruling to the next international congress.

The secretary of the international commission on nomenclature is inviting specialists in other groups to conduct similar studies upon the most prominent and best known genera. The plan adopted is for the secretary to select three or more specialists of unquestioned international reputation in a given group, and to request these workers to add to their committee any colleagues whom they may desire. It is hoped that by this means preliminary studies of fundamental and permanent value may be conducted, and that the contending factions, in respect to nomenclature, may be harmoniously united.

The secretary of the commission on nomenclature is adopting the plan of taking man as a center, first working out, so far as may be done unanimously, names to be adopted for the animals most intimately associated with man, and while the undertaking may require years of patient labor, it is hoped eventually to establish a list of not less than ten thousand generic names, agreed upon unanimously, first by the special committee, and then passed upon unanimously by the commission on nomenclature. It is hoped, further, that by this plan an immense number of useless synonyms can be unanimously agreed upon as such, and gradually eliminated from general zoological literature

The scheme naturally depends upon the amount of cooperation on the part of the special committees, which will be formed as rapidly as the work will justify

C. W STILES,
Secretary International Commission on Zoological Nomenclature

FACTS AND PRINCIPLES

TO THE EDITOR OF SCIENCE: May I have space in your columns to reply to the criticism of Professor R. S. Woodworth in your issue of November 25, on my article, "American Educational Defects," which was printed in SCIENCE on October 28, 1910? I have no desire to enter into any needless controversy, but Professor Woodworth seems to me to have misunderstood my language and misconceived my purpose in a way that makes an answer desirable.

There would be little profit in my discussing with Professor Woodworth whether my article is banal or not, which is purely a matter of taste and judgment; but one observation in this connection seems to me pertinent, namely, that there is nothing particularly novel about truth, and that, if educational inefficiency is as prevalent as I have claimed it to be, it would not be strange if it had

been noted repeatedly, nor that there should be general agreement as to its main cause. I should also like to add the explanation that I did not aim to present novel so much as significant truth, and that in writing I bore in mind the maxim of Dr Johnson to the effect that men need to be reminded rather than informed

It would also be idle to discuss the orthodoxy of my method "Orthodoxy," a witty English bishop once explained, "is my doxy, heterodoxy is another man's doxy," and the same definition will serve for what is sound scientific method to-day I did not aim at orthodoxy of method, but at effective presentation of truth in writing; and it seems to me that this is more important than orthodox procedure In my discussion I had to treat a very large subject within very narrow limits, and there is less detail in it than I should wish, but the practical result of my method was to enumerate certain abuses and limitations that I thought I detected in our educational theories and practises, and to explain them as the result of certain economic and temporal conditions the existence of which I indicated Now whatever the theoretical excellence and unquestioned orthodoxy of Professor Woodworth's method, its practical result in his criticism, if he wished to counteract the effect of what I said, should have been to bring forward some reason for believing that the abuses and limitations that I have pointed out do not exist, and that I am either mistaken or malicious when I say that they do. Instead of this, however, its practical result is to use a great many indefinite expressions as if they had an exact significance, and to claim that my case fails unless college presidents and members of governing boards profit directly from the way they administer their trust.

The question of the consistent and accurate use of language is, I know, quite as indeterminate as the two preceding points I have dealt with, for experience has taught me how the mobile and fluid nature of philosophic ideas prevents their being designated and differentiated with entire success by means of language. In an article as compressed as mine, I had to use far fewer checks and elaborations than the character of the ideas demanded, but in spite of this, I do not feel that Professor Woodworth has demonstrated that I have been guilty of any loose or inconsistent use of language I used the word commerce, I think, consistently as "a gigantic business," founded as much on the caprices as on the necessities of men, an activity which is therefore likely to become dominated by "a pursuit of gain" that is more apparent than real which, instead of being an aid to progress, becomes a corrupting influence by creating an indifference to or an unconsciousness of much good that is equally important but less tangible I did not mean to deny the value of commerce, and I did mean to make clear my opinion that, as a guide for human activity, it is an improvement over anything that has directed society in its earlier stages My purpose was simply to show that the absolute control of thought and aspiration by any one activity is bound to create weaknesses that it is the business of education to strive to correct In using the word commerce in the sense I have given, I have used it in accordance with a definition at once more specific and more comprehensive than Professor Woodworth's definitive one; and I have also, I think, laid more emphasis on its vital principle than on its visible exterior, which seems to me a sufficient explanation of what my meaning is when I say (as he predicted I would) that his criticism is an illustration of a very marked tendency to deal with facts and to neglect principles.

SIDNEY GUNN

MASSACHUSETTS INSTITUTE
OF TECHNOLOGY,
December 2, 1910

SCIENTIFIC BOOKS

The Conservation of Natural Resources in the United States. By CHARLES RICHARD VAN HISE. 8 × 5½ in., pp. xiv + 418, 16 plates. New York, The Macmillan Company. $2.00 net.

As an expert in ores, an authority on geol-

ogy, a leader in education, and a broad student of public affairs, President Van Hise is perhaps better equipped than any one else to treat the natural resources of the country, both in detail and in their relation to the general welfare; and the excellence of his equipment is attested by the completeness and timeliness of his treatise. Conservation of late has become a cult, the influence whereof extends to every section of the country and pervades a large part of our population, yet there is a dearth of data within public reach, partly by reason of the unfortunately limited edition of that three-volume report of the National Conservation Commission containing the fullest inventory ever made of the resources of a nation—and Van Hise's compact book is designed to meet the current condition.

Beginning with a summary history of the conservation movement, the natural sources of national existence are treated in order as mineral resources, water, forests and land, with a general discussion of conservation and mankind. Of the mineral resources the fuels—coal, peat, petroleum and natural gas—are quite properly placed first. Next to America's contribution of a form of government, the most striking fact in the development of the United States is the exploitation of the mineral fuels. This has been done with extraordinary rapidity—virtually within three quarters of a century, chiefly within a generation. The use of mineral fuels not merely made America a manufacturing nation; it multiplied human power over lower nature, and intensified intelligence to a degree revolutionizing the thought of the world. At first idly deemed unlimited in the slack thinking of the time, the use of the abounding natural energy afforded by such fuels so stimulated both industrial and mental growth that new methods arose, especially that quantitative method which forms perhaps the highest expression of human advancement—and as the quantitative method naturally extended to the coals both their limits and the wastes of earlier exploitation were realized and finally measured. The United States contains 60 or 70 per cent of the coal of the world, and is more richly endowed with petroleum and natural gas than any other country; yet the wastes were long greater than the uses, and even yet combustion is so imperfect that only a small fraction (probably less than 10 per cent) of the thermal energy of the coal is actually utilized. But new standards are arising with the spread of the conservation movement, heedless waste is reprobated and is rapidly diminishing, while incomplete utilization is receiving attention, and engineers and inventors are devising means for more complete combustion of the coal and larger application of its energy to the development of power. Paradoxically enough, it would appear that the age of steam opened through the mineral fuels will be closed through better use of the same sources of energy; for coal gasified and used in gas engines averages twice the efficiency of the same coal burned under the steam boiler. America's coal underlies an area of some 500,000 square miles, or 13 per cent of the country, and is estimated to amount to three trillion tons, of late it is mined at the rate of about 450,000,000 tons annually, or say 5 tons per capita for our people, at the current rate of use it would last several thousand years, while at the currently increasing rate (doubling once in seven or eight years) it would be exhausted within 150 years.

Next to coal it was iron that made this country industrially great; the high-grade ores have for a half-century been taken out of the ground and converted into finished product at a rate marking an epoch in world history. When the nation was founded a few pounds of iron sufficed for the average family; now the production exceeds 25,000,000 tons each year, or nearly 700 pounds for each man, woman and child of our entire population. Of high-grade ores we have less than 5,000,000 tons; at the currently increasing rate of mining it would not outlast the middle of the present century—though with proper economy and progressive recourse to low-grade ores the life of the supply will be prolonged at relatively increasing cost.

In no direction is the quantitative method of dealing with resources more novel and helpful than in connection with water—at once a mineral and the menstruum of vitality; and Van Hise applies the method effectively. The average rainfall of the United States is about 30 inches, or only half that required for full productivity of the soil; the aggregate volume is 215,000,000,000,000 cubic feet; or, expressed in terms already familiar throughout the semi-arid region, about 5,000,000,000 acre-feet annually—equivalent to ten Mississippi rivers flowing constantly. Of the total, about one third runs down to the sea in rivers of which many are navigable though little used in aid of commerce—for with the habitual extravagance of the world's wildest wasters our people prefer to pay three or four times the cost of water transportation for carriage of their abounding freight by rail. This is the run-off; and the remaining two thirds (forming the fly-off and the cut-off) are considered with respect to both uses and wastes. Not only are the leading facts well brought out, but the equities arising in connection with this resource are discussed with clearness and conviction. It is growing evident—indeed, it is already recognized by many influential citizens—that in the last analysis the waters of the country belong to the people of the country, and must be administered in their interest, and Van Hise cites and discusses the laws and decisions taking this trend.

Our once abounding but now sadly depleted forests are treated along the lines established by the work of the forest service, *i. e.*, at once as sources of timber, preservers of streams and enhancers of the beauty and habitability of the country as a home for a prosperous and patriotic people; and the extent, uses and wastes of the forest resources are listed and discussed in informing fashion. The lands are treated largely with reference to production—a production measured partly by the soil but yet more largely by the water applied to it naturally or through irrigation. Before the exploitation of the mineral resources and timber began, America was the home of a freehold landed citizenry, and the abounding products of the soil not only easily sustained the food-producing population of the time, but left a large margin for export; but now that a large part of our people are engaged in manufacturing and ancillary industries rather than in producing staples for food and clothing, our exports of these staples are declining—and even at home the pinch of reduced production is felt in advancing prices. It is clearly a need of the time to augment the yield of staples, not merely per acre cultivated, but per worker in the field, it is not only needful to make two ears of grain grow where one grew before, but the farmer must double or triple the product of his own work in order that his manufacturing fellows may be fed; and this may be attained by judicious conservation of the energy residing in fertile soil and intelligent husbandry. For even the teeming population of to-day is not the end for this country, our inhabitants and industrial differentiation are increasing with each generation, and must continue to increase apace if this nation is to fulfill its manifest destiny as the chief home and strength of the Caucasian race. Consistently, Van Hise urges conservation and increase of the elements of fertility in the soil; he indicates and deplores the wastes due to soil erosion and negligent farming; and he applies his own expert knowledge in describing the phosphate deposits of the country and advocating their retention and use. In his closing division he especially emphasizes the current movement as one connected with the public welfare and brings out its patriotic character—for in very fact the perpetuity of this most exuberant and wasteful of nations is at stake.

Throughout, Van Hise crystallizes conservation as a definite and trenchant idea, a specific principle, a basis and guide for action: "Do the principles of conservation demand that it [legislation] shall be done?" (p. 97), "Conservation requires us to encourage concentration and coupling in order that we may get the greatest efficiency of the water" (p. 135); "Conservation does not demand that no tree be cut, but that whenever a

tree is cut, measures shall be enforced which will produce another tree" (p 262)—these are typical expressions.

The book is an outgrowth of a series of twenty lectures, and the arrangement and style reflect the original presentation, there are occasional discontinuities and other minor imperfections which systematic construction in the study would have obviated. In view of that trenchant application of the quantitative method which the conservation movement expresses, it is unfortunate that the indefiniteness of thought and cloak for sharp practise involved in the "long ton" should find expression, still less the rhetorical monstrosity, "short ton", as if there were in well-chosen American terminology any "short" ton—save that delivered by a dishonest dealer. A misleading expression is "reserves," applied to natural supplies—a term unhappily introduced in this country by a foreign student and carelessly adopted through mimetic instinct, there is indeed a "gold reserve," and there have been "forest reserves," but there are unfortunately no coal reserves or iron reserves in the United States—and the very use of the term tends to confuse thought and thereby retard desirable action.

On the whole, despite the few minor blemishes sure to disappear in later editions, Van Hise's book is a highly useful summary of the facts and statement of the principles involved in the conservation movement; and its issue would seem to meet an urgent need.

W J M.

Theoretical Principles of the Methods of Analytical Chemistry Based upon Chemical Reactions. By M. G CHESNEAU Authorized translation by AZARIAH THOMAS LINCOLN, Ph.D. and DAVID HOBART CARNAHAN, Ph.D. New York, the Macmillan Company. 1910. Pp. x + 184 $1 75 net.

The book attempts to show that the phenomena and methods of analytical chemistry can be established on a theoretical basis of thermochemical data and thermodynamic principle, without the use of the electrolytic dissociation theory. In other words, it represents a systematic attempt at practical application of the views held by opponents of the dissociation theory, notably by Professor Kahlenberg

It is divided into seven chapters. The first examines "the influence of the physical state of precipitates upon their purification by washing (size of grains, crystalline state, colloidal state)" The second chapter deals with the principal types of irreversible reactions used in analysis and with the theoretical principles involved The third chapter deals with reversible reactions from the thermodynamic standpoint, carefully avoiding the use of the electrolytic dissociation theory· ionic concentrations are absent from the mass law equations, the molar concentrations being raised to empirical fractional powers (Van't Hoff's coefficient *i*). The fourth chapter introduces the theory of solutions and includes a brief statement of the principal facts upon which the dissociation theory rests. The fifth chapter is devoted to an attempt to show that the dissociation theory can no longer be maintained in science and that it is decidedly overthrown by the work of Kahlenberg. The sixth chapter deals with analytical processes based upon double decomposition of salts Here for the first time the principle of constancy of the solubility product is stated, then an attempt is made to show that it can be dispensed with, not only without loss, but with gain In the last chapter we find, as a substitute for the Ostwald theory of indicators, one based upon "thermochemical data and the hydrolysis of salts in solution" and having "its origin in the principles set forth by Berthelot in his *Thermochimie*" (p. 167). We read here that the change of color of an acid indicator is due to the difference in color between the free acid and its alkaline salt.

On page 127 we read· "If the contradictions between the facts and the theory of ionization appear to require the rejection of the latter, one falls then into another difficulty, that of not explaining the necessity of introducing the coefficient *i* into the general law of equilibrium of Guldberg and Waage." The author thinks, however, that the molecular

association of liquids and its working in the case of salt solutions, together with the hydrolysis idea as set forth by Reychler, fully suffice to explain the chemical peculiarities of salt solutions "... The two parts into which a salt dissolved in water ought necessarily to separate in order to produce a double decomposition, are not hypothetical electrical ions, but a *real* base and acid coming from the chemical action of water upon the salt in solution" (p 133)

It would be of little use to undertake here to defend the dissociation theory Besides, one would mostly have to repeat what was written on various occasions, during the storm and stress period of the theory, by Ostwald's powerful pen Thus, referring to Reychler's hydrolysis idea, Ostwald pointed out in 1893: "Unfortunately, the author has omitted to state how his hypothesis works in the case of salts of insoluble acids or bases, how, for instance, 50 to 80 per cent of zinc hydroxide can remain dissolved, without precipitating out, in a solution of zinc sulphate or zinc chloride"[1] It might also be asked, why a strong solution of common salt, if it contains a great deal of free hydrochloric acid, does not invert ordinary cane sugar, and so forth, and so forth But we will not insist.

The best friends of the dissociation theory have come to feel that it is insufficient, that it needs modification, or rather, perhaps, some addition. But its quantitative triumphs have been remarkable *It will not go unless some new theory is brought forward that will do all that the dissociation theory has done, and more, and that on a quantitative basis, in the way of correlating apparently disconnected phenomena.*

Chesneau's book contains no such new theory, and its blow at the dissociation idea will scarcely be felt. Nevertheless, its contents will be of interest to research students of the theory of solutions. It certainly is well written, well translated by Professors Lincoln and Carnahan, and beautifully published by the Macmillan Company.

M. A. ROSANOFF

[1] See *Zeit. physik. Chemie*, XII., p 800, 1893

SCIENTIFIC JOURNALS AND ARTICLES

THE recent numbers of the *Journal of Pharmacology and Experimental Therapeutics* contain the following articles:

Vol. I, No. 5.

"Anastomosis between the Portal Vein and the Inferior Vena Cava (Eck's Fistula,)" by B. M. Bernheim, John Homans and Carl Voegtlin.

"The Pharmacologic Action of Certain Protein Cleavage Products upon the Heart," by R. B. Gibson and W H Schultz

"The Influence of Alcohol on the Composition of the Urine," by W Salant and F C Hinkel

"A Poisonous Principle in Certain Cotton-seed Meals," by Albert C Crawford.

"Physiological Studies in Anaphylaxis I., The Reaction of Smooth Muscle of the Guinea-pig Sensitized with Horse Serum," by W H. Schultz.

Proceedings of the American Society of Pharmacology and Experimental Therapeutics.

Vol I, No 6

"An Experimental Study of the Functional Activity of the Kidneys by Means of Phenolsulphonephthalein," by L. G Rowntree and J. T. Geraghty

"A Practical Method for the Preparation of Phenolsulphonephthalein," by Edgar A Slagle.

Vol II, No. 1

"The Action of Drugs on the Salivary Secretion," by V. E. Henderson

"Thyreotropic Iodine Compounds," by Reid Hunt and Atherton Seidell.

"On Insufflation of the Lungs with Hydrogen; with Carbon Dioxide, and with Air," by C. C. Guthrie, F. V. Guthrie and A. H. Ryan.

"The Influence of Intravenous Injections of Sparteine and Adrenalin on the Heart of the Dog," by A Strickler and Moyer S. Fleisher.

"In regard to the Detoxification of Benzoic Acid by Optical Isomers of Leucin," by A. H. Koelker and Samuel Amberg

"On the Toxicology of the Tutu Plant," by W. W. Ford.

Vol. II, No. 2.

"On the Action of Magnesium Sulphate," by S. A. Matthews and Clyde Brooks.

"On the Efficacy of Antimony-thioglycollic Acid Compounds in the Treatment of Experimental Trypanosomiasis," by John J. Abel and L. G Rowntree.

"Further Observations on the Immunization of Animals to the Poisons of Fungi," by W. W. Ford.

"Expectorants," by V E. Henderson and A. H Taylor.

SPECIAL ARTICLES

ELLIPTIC INTERFERENCE IN CONNECTION WITH REFLECTING GRATING

In my earlier papers[1] and in a forthcoming theoretical account of the subject, I have shown the practical advantages obtained by associating the interferences of thin plates with the diffractions of the transparent grating—a subject originally suggested to me by the phenomenon of coronas, in which a marked interference phenomenon was also superposed on the diffractions These elliptic fringes may, however, be evoked in other ways than those discussed, and it is to some of these that I venture to refer here

Let the oblique mirror in Michelson's apparatus, for instance, be the usual plate of glass and replace the two opaque mirrors *M* and *N* by identical small reflecting gratings, set at the angle of diffraction of the spectrum, symmetrically to the incident rays Here the elliptic interferences will be seen in the telescope at right angles to the rays issuing from the collimator This adjustment is virtually the same as the plan of returning the diffracted spectra normally to the oblique transparent grating, discussed in the preceding paper in this JOURNAL. The fringes are rings.

Again, in a simple spectrometer adjustment for grating spectra, suppose the grating (either transmitting or reflecting) to be separated into two halves by a division parallel to the ruling. Then on displacing one of the halves, micrometrically, parallel to itself from its original coplanar position, elliptic interference must show itself in a way which is perhaps more direct than any of the methods hitherto treated. The fringes are straight.

CARL BARUS

BROWN UNIVERSITY, R. I.

[1] SCIENCE, XXXII., 1910, p. 92; *Am. Journal of Science*, XXX., 1910, p. 161.

THE AMERICAN SOCIETY OF NATURALISTS

The twenty-eighth annual meeting of the American Society of Naturalists was held in the auditorium of the New York State College of Agriculture at Cornell University on December 29 and 30 The eastern branch of the American Society of Zoologists so arranged its program that members were enabled to attend the Naturalists' meeting Many of the members of the Association of Anatomists and American Society of Bacteriologists which were meeting in Ithaca also attended the program Although the Botanical Society of America met elsewhere a number of botanists came instead to the meetings of the Naturalists It may fairly be said, judging from the number present at both sessions, that the Naturalists' symposium was the chief feature of general interest at the entire Ithaca meetings

The one cause of general regret was the unavoidable absence of the president, Dr D T MacDougal, who was ill in the Johns Hopkins Hospital. President MacDougal had so carefully planned the program and had done so much to instill enthusiasm into the entire arrangements that all felt the pronounced success of the occasion to be the result of his efforts

Dr MacDougal's well thought-out and richly suggestive address on "Organic Response" was read at the annual dinner of the society by the vice-president, Professor H S Jennings.

At the meeting of the executive committee and at the business session of the society there was a general expression of the feeling that the present affiliation of the biological societies was highly desirable. The Anatomists, Bacteriologists, Zoologists and Naturalists which met at Ithaca might meet comfortably at many of the universities of the country which are situated, as Cornell is, in a small town It was also felt that there was a far more favorable opportunity for personal discussions and exchange of ideas at a smaller meeting than at a more general one.

The Anatomists, Zoologists and Naturalists had a joint smoker at the Ithaca Hotel on Wednesday evening.

The Naturalists' dinner was given on the following evening at the Ithaca Hotel and was well attended. After the dinner the president's address was read.

The scientific program was given on Thursday afternoon and on Friday both fore- and afternoon.

The central topic of the discussions was the pure line conception in the study of inheritance and evolution Most of the papers in the first part of the program seemed to support the views of Professor Johannsen, while several of the later papers on the program seemed to strongly suggest that selection and a modified Lamarckian view were yet to account for important factors in the

production of new species The valuable feature of the program was the forcible way in which the opposing evidence and ideas of species formation were presented by the several participants. Professor Johannsen, of Copenhagen, who has so strikingly expounded the principles of pure lines and genotypes in the study of inheritance, sent a most suggestive paper to be read before the symposium.

PUBLICATION OF PAPERS

The address of the president and all papers read before the society will appear in series in the forthcoming numbers of *The American Naturalist*

The importance and scope of the papers read are shown by the following titles

H J Webber, Cornell University, "What is a Genotype or Biotype?"

H S Jennings, Johns Hopkins University, "Pure Lines in the Study of Genetics in Lower Organisms"

E. M. East, Bussey Institute, "The Genotype Hypothesis and Hybridization"

W Johannsen, University of Copenhagen, "The Genotype Conception of Heredity"

Geo H Shull, Carnegie Institution, "The Genotypes of Maize"

T H Morgan, Columbia University, "The Application of the Conception of Pure Lines to Sex-limited Inheritance and to Sexual Dimorphism."

J Arthur Harris, Carnegie Institution, "The Biometric Proof of the Pure Line Theory"

R. A Emerson, University of Nebraska, "Some Genetic Correlations in Maize and their Relation to the Formation of New Genotypes through Hybridization"

R. Pearl, Maine Agricultural Experiment Station, "The Inheritance of Fecundity in the Domestic Fowl"

W E Castle, Harvard University, "Are Unit Characters Subject to Modification by Selection?"

F B Sumner, United States Fisheries, "Some Effects of Temperature upon Growing Mice and the Persistence of such Effects in a Subsequent Generation"

J H Gerould, Dartmouth College, "Polymorphism and Inheritance in *Colias Philodice*"

S Hatai, Wistar Institute, "On the Mendelian Ratio and Blended Inheritance."

M F Guyer, University of Cincinnati, "The Nucleus and Cytoplasm in Inheritance"

Many of the papers were followed by interesting discussion, but unfortunately the program proved to be too long to allow full time for this desirable feature.

Several valuable demonstrations were displayed by members of the society

NEW MEMBERS

The following were elected members of the Naturalists J F Abbot, Washington University; R A. Emerson, University of Nebraska; A. W. Gilbert, Cornell University, L. Griggs, Dartmouth College; A Gulick, University of Toronto; J A Harris, Carnegie Institution, S Hatai, Wistar Institute, H. E Jordan, University of Virginia, A. E Lambert, Massachusetts State Normal School, C C. Little, Bussey Institute; H H. Love, Cornell University, S. O Mast, Goucher College; G. T. Moore, Washington University; J. C Phillips, Bussey Institute, R. E. Sheldon, University of Pittsburgh; A. F. Shull, Columbia University; W J. Spillman, U. S. Department of Agriculture, H. B. Torrey, University of California, G. Wagner, University of Wisconsin, H J. Webber, Cornell University; E. N. Wentworth, Iowa State College, D D Whitney, Wesleyan University

The following officers were elected for 1911:

President—Professor H. S. Jennings, Johns Hopkins University

Vice-president and Chairman of Eastern Branch—Dr Geo H. Shull, Carnegie Institution.

Treasurer—Professor E. M East, Bussey Institute.

Secretary—Professor C. R Stockard, Cornell University Medical School

Additional Members of Executive Committee—Professor W L Tower, University of Chicago, and Dr B. M Davis, Cambridge, Mass.

CHAS R. STOCKARD,
Secretary

THE AMERICAN CHEMICAL SOCIETY

THE forty-third general meeting of the American Chemical Society, held at Minneapolis, December 28–31, was attended by 275 members and guests and, like all recent meetings of the society, was simply an echo of the general enthusiasm that pervades its membership.

Owing to the fact that over 175 papers were presented, it was necessary to hold meetings of all of the divisions and the meetings of the Division of Agricultural and Food Chemistry, Division of Fertilizer Chemistry, Division of Pharmaceutical Chemistry, Division of Industrial Chemists and Chemical Engineers, Division of Physical and Inorganic Chemistry and Division of Organic Chemistry, were well attended.

A point especially worthy of note was the

successor of the Biological Section under the chairmanship of Dr Carl L Alsberg, of Washington, D. C. Forty four papers were presented before this section of a strictly chemical nature bearing upon biochemical problems

The meeting of the Section of Chemical Education, held at a time when all the industrial chemists could meet with them, proved decidedly interesting and the discussion was general.

On the first day of the meeting the chemists all gathered in general session to listen to eight general addresses as follows

"The Lost Arts of Chemistry," W D. Richardson

"The Basis of Industrial Efficiency," A D Little.

"Synthetic Metals from Non metallic Elements," Herbert N McCoy

"Progress in Food Chemistry," H E Barnard

"Mechanism of Cell Activity," Carl L Alsberg.

"Waste Wood and some of its By products," Geo. B. Frankforter

"The Formation of Carbohydrates in the Vegetable Kingdom," Wm McPherson

"The Efficiency of the College Graduate in the Chemical Industry," Chas F Burgess

The address of the retiring president, Wilder D Bancroft on "A Universal Law," was an exposition of the general application of the theorem of Le Chatelier to all kinds of natural phenomena as well as those of a chemical nature

Possibly the complimentary smoker in the rooms of the Commercial Club was as thoroughly enjoyed as any one feature of the meeting for an unusually witty program had been arranged and original songs bearing upon individual chemists and chemical phenomena were thoroughly enjoyed; also the mementoes furnished to the visiting chemists were pleasing to all This, however, was not the only social function of the meeting, for several receptions and teas were arranged for the ladies and the banquet on Friday night, which was attended by some two hundred members, was also graced by their presence

Excursions to the following places and works were taken by the members Russell Miller Milling Co, Pillsbury Flour Mills Co, Washburn-Crosby Co, Consolidated Milling Co, Minnesota Linseed Oil and Paint Co, Archer-Daniels Co, Midland Linseed Oil Co, St Anthony Falls Water Power Co, Cream of Wheat Co and International Stock Food Co.

On Saturday afternoon a large number were treated to a sight seeing trip covering both the cities of Minneapolis and St Paul A number of the chemists also had the privilege of viewing the wonderful paintings of La Farge in the state capitol of Minnesota

The announcement of the election of Alexander Smith as president of the society and of Louis Kahlenberg, Frank K Cameron, Geo B Frankforter and E C Franklin and E G Love as councilors at large met with hearty approval and applause

M C Whitaker was elected editor of the *Journal of Industrial and Engineering Chemistry*, and the report of a committee recommending a decided broadening of the policy of that journal was adopted

The secretary announced a net gain of 550 members for the year the society now having a membership of over 5,100

CHARLES L PARSONS,
Secretary

THE TWENTY-THIRD ANNUAL MEETING OF THE AMERICAN PHYSIOLOGICAL SOCIETY, NEW HAVEN, CONN., DECEMBER 27–30, 1910

For the first time in many years the physiologists of the country, together with the biochemists and the pharmacologists, met apart, not only from the American Association for the Advancement of Science, but also from the group of societies associated with the naturalists Sixty three of the society's one hundred and seventy-five members were present The meeting was successful in point of attendance as well as in the number of communications of high merit and in able discussions An important factor in the success of the meeting was the splendid arrangements made for us by the local committee (the biologists of the Sheffield Scientific School, the Yale Medical School and the Connecticut Agricultural Experiment Station) and the cordial hospitality extended by this committee to the visiting members

The following papers and demonstrations were presented and discussed during the six scientific sessions (two of these being joint sessions with the biological chemists)

E B Meigs, "The Osmotic Properties of Smooth Muscle"

Gertrude F Barbour and P E Stiles, "Localized Activity in Skeletal Muscle"

C J Wiggers, "Pulse Pressure Variations in the Pulmonary Circuit"

G W Fitz, "A Preliminary Report of Work

with the Shadow Pupillometer in Determining the Constants of Pupillary Reactions"

G H Parker, "The Olfactory Sense in Fishes"

F C Becht and A B Luckhardt, "On the Source of the Immune Bodies in the Lymphs"

J R Murlin and J R Greer, "The Heart Action in Relation to the Respiratory Metabolism"

W B Cannon and C W Lelb, "The Receptive Relaxations of the Stomach"

S Simpson, "Are the Parathyroids Capable of Replacing the Thyroids Physiologically?"

L Loeb, "The Function of the Corpus Luteum"

T B. Osborne and L B Mendel, "Feeding Experiments with Mixtures of Isolated Food Substances"

Elizabeth Cooke and S P Beebe, "Autolysis of Liver as Affected by Thyroid Administration"

J Loeb, "Further Experiments on the Antagonistic Action of Salts"

O Schreiner and M X Sullivan, "Biological Analogies in Soil Oxidation"

S J Meltzer, "The Migration of Solutions in Animal Bodies Deprived of their Cardiac Circulation"

G N Stewart, "Measurement of the Blood Flow in Man"

W H Howell, "The Action of Pure Thrombin"

G W Fitz, "A Shadow Pupillometer for the Accurate Study of Pupillary Reactions"

S Simpson, "A Modification of Schäfer's Frog-heart Plethysmograph"

Y Henderson, "A Quantitative Pneumograph"

E D Jackson, "An Automatic Shellacking Device"

A J Carlson, "The Mechanisms of Automaticity, Coordination and Conduction in the *Limulus* Heart" (Demonstration)

A B McCallum, "Some Illustrations in Animal and Vegetable Cells of the Gibbs-Thomson Law of Surface Condensation of Solutes"

H Cushing, E Goetsch and C Jacobson, "The Hypophysis and its Relation to Carbohydrate Tolerance"

H C Jackson, "Changes in the Blood and Tissues following Double Nephrectomy and Urethral Ligation"

J Auer, "The Causation of Acute Anaphylactic Death in the Rabbit"

J R Murlin and L. H. Mills, "The Influence on Metabolism of Oils given Subcutaneously and Intravenously"

A B Luckhardt and F C Becht, "The Relation of the Spleen to the Fixation of Antigens and the Production of Immune Bodies"

P A Grant, Elanor Van Alstyne and S. P. Beebe, "The Absorption of Protein through the Intact Intestinal Epithelium"

F Wills and P B Hawk, "The Stimulation of the Gastric Secretion under the Influence of Water-drinking with Meals"

V E Henderson, "The Effect of Temperature upon the Heart"

J S Miller, D D Lewis and S A Matthews, "The Effects of the Intravenous Injection of Extracts of the Different Parts of the Hypophysis"

W B Cannon, "Observations on the Nature of Gastric Peristalsis"

F H Pike, "The Mechanism of the Asphyxial Rise of Blood Pressure in the Spinal Animal"

J. A E Eyster, "The Effects of the Intravenous Injection of Extracts of the Pineal Body"

D R Joseph and S J Meltzer, "Inhibition of the Duodenum Coincident with the Movements of the Pyloric Part of the Stomach"

A J Carlson, J. R Rooks and J R. McKie, "Attempts to Produce Experimental Hyperthyroidism in Different Animal Groups" (with demonstrations)

Owing to the absence of the authors the following papers were read by title only.

W Koch and C C Todd, "The Nature of the Chemical Combinations of Potassium in the Tissues."

A Hunter and M H Givens, "The Allantoin and Purin Metabolism in the Monkey"

T G Brodie, "The Gaseous Metabolism of the Heart"

G Lusk, "A Method of Removing the Glycogen in the Human Subject"

P B Hawk, "The Activity of the Pancreas during Moderate and Copious Water Drinking with Meals"

W M Hattrem and P B Hawk, "On the Intestinal Putrefaction during Copious and Moderate Water drinking with Meals."

Clara Jacobson, "On the Mechanisms of Inhibition of the Parathyroid Tetany in Mammals by Calcium Salts"

W Jones, "A Specific Nuclease for Guanylic Acid"

The society appropriated $100 to the *American Journal of Physiology* towards defraying the cost of the index volume

The following new members were elected:

Harvard University J H Pratt, W. J. V. Osterhout, A Forbes

University of California T B Robertson, S. S Maxwell

Washington University W E Garrey, D E Jackson.

University of Pittsburgh C Brooks, R E. Sheldon.

Cornell University J R Greer, E Sachs, J F. McClendon.

Columbia University W G MacCallum

Western Reserve University D Marine

Yale University L L Woodruff

The following officers were elected for the year 1911:

President—S J Meltzer

Secretary—A J Carlson.

Treasurer—W. B Cannon

Members of the Council—J Erlanger, F S Lee

A J CARLSON,
Secretary

UNIVERSITY OF CHICAGO

THE AMERICAN MATHEMATICAL SOCIETY

The seventeenth annual meeting of the American Mathematical Society was held at Columbia University on Wednesday and Thursday, December 28–29, 1910, extending through the usual morning and afternoon sessions on each day Sixty-two members were in attendance President Maxime Bôcher took the chair at the opening session, yielding it to Professor Kasner, Ex-president Osgood, and at the morning session on Thursday to the president-elect, Professor H B Fine The council announced the election of the following persons to membership in the society Professor Percy Hodge, Columbia University; Mr C G P Kuschke, University of California, Professor Marion B White, University of Kansas Eight applications for membership in the society were received

On Wednesday evening thirty of the members gathered at the annual dinner, which has for many years been a pleasant adjunct to the regular sessions

It was decided to hold the summer meeting of the society at Vassar College in 1911, and at the University of Pennsylvania in 1912 A committee, consisting of Professors H. S White, P F Smith and the secretary, was appointed to make the necessary arrangements for the summer meeting of 1911

At the annual election, which concluded on Thursday morning, the following officers and other members of the council were chosen

President—Professor H B Fine.

Vice-presidents—Professors G A Bliss and W. R. Berry

Secretary—Professor F N. Cole

Treasurer—Professor J H Tanner

Librarian—Professor D E Smith

Committee of Publication—Professors F N Cole, E W Brown and Virgil Snyder

Members of the Council (to serve until December, 1913)—Professors H F Blichfeldt, J L Coolidge, C J Keyser and J W Young

The total membership of the society is now 642, including 60 life members, an increase of 24 during the past year The total attendance at all meetings of the year was 317, the number of papers presented was 145, 202 votes were cast at the annual election The treasurer's report shows a balance of $8,124 53, a slight increase over last year, although the university subventions for the *Transactions*, amounting to $500 per annum, have been discontinued and the society has paid an installment of 1,000 francs of its contribution toward the publication of the works of Euler The income from sales of the society's publications during the year was $1,660 21 The life-membership fund now amounts to $3,901 83 The library shows the normal increase, the total number of books on the shelves being now 3,508

During the past sixteen years the society has expended for printing the *Bulletin*, *Transactions* and other publications $42,473 57 The total returns from publications have been in the same period $15,375 20 The stock of publications on hand may be fairly valued at about $10,000 The university subventions have amounted to $8,100 Editorial and administrative expenses during the sixteen years have been $11,739 14 The society is about to undertake the publication of the Princeton Colloquium Lectures and the republication of Klein's Evanston Lectures

The following papers were read at the annual meeting

S Chapman "A note on the theory of summable integrals"

H. H Mitchell "Concerning a rotation group in six-space"

Virgil Snyder "An application of a (1–2) quaternary correspondence"

A S Hawkesworth "Three new dimension theorems"

W R Longley "Singular points on the discriminant locus of an ordinary differential equation"

R G D Richardson "Theorems of oscillation for two self adjoint linear differential equations of the second order with two parameters"

Maxime Bôcher "A simple proof of a funda

mental theorem in the theory of integral equations"

J L Coolidge "The metrical aspect of the line sphere transformation"

E J Miles "The absolute minimum of a definite integral in a special field"

J C Fields "A method of proving certain theorems relating to rational functions which are adjoint to the fundamental algebraic equation for a given value of the independent variable"

F F Decker "On the order of a restricted system of equations"

Paul Saurel 'On the classification of crystals"

A B Coble "An application of Moore's cross ratio group to the solution of the sextic equation"

A B Coble "The cubic surface and plane six point"

C L E Moore "Conjugate directions on a hypersurface in S_4 and some allied curves"

W H Bates "An application of symbolic methods to the treatment of mean curvature in hyperspace"

H B Phillips "The Galois theory of sets of multipartite variables"

J R Conner "Correspondences associated with the rational plane quintic curve"

L P Eisenhart "Conjugate systems and envelopes of spheres"

Joseph Lipke "Natural families of curves in a general curved space of n dimensions"

O E Glenn "On the discriminants of ternary forms"

Professor Bates's paper will appear in full in the January *Transactions* Abstracts of the other papers will be included in the secretary's report in the March number of the *Bulletin*

The Chicago Section of the society held its twenty eighth regular meeting at the University of Chicago, December 28–30 The next meeting of the society will be held at Columbia University on Saturday, February 25

F N Cole,
Secretary

THE SOUTHERN SOCIETY FOR PHILOSOPHY AND PSYCHOLOGY

The sixth annual meeting of the Southern Society for Philosophy and Psychology was held at Chattanooga, Tenn, December 27 and 28, 1910 The meetings were presided over by Professor Edward Franklin Buchner, who delivered the presidential address on the topic "Learning and Forgetting"

The following papers and reports [illegible]

Thomas P Bailey, New York Bu[illegible]nicipal Research, "Some supposed [illegible]encies of the American Negro A [illegible] Psychological Study of the Race Prob[illegible]"

Jasper C Barnes, Maryville Co[illegible], "[illegible] Pressure Curve in Voluntary Control"

Knight Dunlap, Johns Hopkins Uni[illegible], "A Study in Rhythm Perception"

David Spence Hill, Peabody College [illegible]ers, (*a*) "Some Needs for Child Wel[illegible] South," (*b*) "Class and Practise Ex[illegible]," (*c*) "A Comparative Study of Children[illegible]"

A J McKelway, secretary, Natio[illegible] Labor Committee for the Southern Stat[illegible] Labor in its Relation to Education"

R M Ogden, University of Tenn[illegible], (*a*) "The Order of the Days of the Wee[illegible] Pythagorean Philosophy," (*b*) "Kno[illegible] Expressing"

Jno Pickett Turner, Vanderbilt U[illegible], 'Locke's Place in the History of Thoug[illegible]"

Tom A Williams, Washington, D C, [illegible]) "[illegible] Modern Interpretation of Dreams and [illegible], Sleeping and Waking," (*b*) "Intellec[illegible] cocity The Rôle of the Inclinations and[illegible]ity A Comparison of the Principles and [illegible] employed for educating John Stuart [illegible] Boris Sidis's Son"

The officers elected for the year 1[illegible]: *President*—Dr Shepherd Ivory Franz[illegible]ment Hospital for the Insane, *Vice p*[illegible]— Professor A Caswell Ellis, University [illegible] *Secretary treasurer*—Professor R M[illegible], University of Tennessee

Vacancies in the council were filled [illegible]tute that body as follows for a three y[illegible], Professors E F Buchner, Johns Hop[illegible]versity, and W B Smith, Tulane U[illegible]; for a two year term, Professor Bruce [illegible], University of Virginia, and Presiden[illegible] Pearce, Breneau College, for a one-y[illegible], Professors David Spence Hill, Peabody [illegible] for Teachers, and W C Ruediger, Geor[illegible]ington University

It was voted to hold the next meeti[illegible] society at Washington, D C, in affilia[illegible] the American Association for the Adva[illegible] Science, provided the American Psychol[illegible] Philosophical Associations meet at the [illegible] and time

R M O[illegible],
[illegible]

// SCIENCE

FRIDAY, JANUARY 27, 1911

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MSS. intended for publication and books, etc., intended for review should be sent to the Editor of SCIENCE, Garrison-on-Hudson, N. Y.

THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

THE METHOD OF SCIENCE[1]

SCIENCE governs human life by determining the conditions of existence and by furnishing the means of civilization. Religion prescribes the motives, government formulates the customs of mankind, science fixes what we can do and how. If, at the present meeting, we appropriately emphasize the rôle of science, it does not imply that we belittle the ethical or social factors of civilized life, but answers the demand for a more just and general recognition of the actual importance of pure science.

We are so accustomed to the practical advantages that have followed from abstruse science, that we connect them with their source only by a distinct mental effort. The wonders of practical science have been recited so often, that their reiteration has become tedious, and we no longer feel strongly impelled to felicitate mankind on the parlor match, the telephone and the antitoxines, although we indulge at present in an unsubdued excited anticipation of wonders to come, especially in the domain of medicine. Are we not all on the watch for the announcement of the cure for cancer, and vaguely for other new and astounding reliefs from disease! Such concentration of interest upon novel practical results is not wholly favorable to science.

It is true that a large amount of investi-

[1] Vice-presidential address delivered before the Section of Physiology and Experimental Medicine of the American Association for the Advancement of Science, at Minneapolis, December 29, 1910.

gation is going on which aims to secure immediate practical results. In chemistry and medicine especially the activity in the work of applied science is very great. This condition gives a powerful fresh reason for defending pure abstruse science. Applied science always has been, is now, and probably always will be distinctly subsidiary to pure science The final justification of all scientific research is undoubtedly the power it creates for the use of mankind, but the power must be created before it can be used A little study of the history of science should suffice to convince any reasonable mind that the command we possess to-day over nature is due to the labors of men, who have almost invariably pursued knowledge with a pure devotion uncontaminated by any worship of usefulness These devoted idealists have gathered the varied mighty harvests by which all men have profited, but the debt of gratitude to them is unpaid.

The pursuit of abstruse science needs to be encouraged. It is insufficiently esteemed This doctrine ought to be emphasized on all suitable occasions, but especially before the section of experimental medicine The people cry for relief from sickness and their demand for prompt useful discoveries is so urgent that there is danger in it, since it tempts medical investigators away from the fundamental enquiries, which, answered, will give great results, and seduces them to work exclusively at secondary problems, from the solution of which quicker, but smaller results may be expected. Pure science is broad, it embraces all. Applied science is a congery of fragments, of isolated problems, which lack cohesion and are without any necessary connection with one another. It is easy to understand why students of applied science have seldom made great discoveries.

In fact, scientific knowledge will not be compelled We have to take what knowledge we can get, and by no means can we get always what knowledge we want Pure science adapts its undertakings to these rigid conditions, and works where the opportunity is best—not so applied science.

Let us recall a few of the epoch-making discoveries When Galileo turned his [illegible] face up towards the swinging lamp in the Cathedral of Pisa and as he looked discovered the law of the moving pendulum, he was in quest of pure knowledge We can not conceive such a man actuated by any lower motive. Even when we learn of his astonishing the Venetian merchants by enabling them to see their far-off vessels through his newly invented telescope, do we not feel that it was merely an episode to Galileo? Such a man does not ask, "What use is it?" His demand for knowledge was insatiable. When Newton thought out the problem of gravity and his theory of planetary motion; when Malpighi explored the structure of animals with his crude microscope; when Lavoisier created modern chemistry; when Cuvier combined comparative anatomy and paleontology and made the combination yield new revelations; when Lyell proved geological history to be an evolution and not a succession of cataclysms; when von Baer against immense difficulties traced the development of the chick; when Schwann demonstrated the correspondence of cellular structure in animals with that of plants—was one of them actuated primarily by the wish to get practical results? We have only to read their works to convince ourselves that they were all in search of knowledge for knowledge's sake. Yet they are the giants of human history, who in importance are approached by few monarchs or statesmen. Compared with the growth of science the shiftings of govern-

ments are minor events. Until it is clearly realized that the gravest crime of the French revolution was not the execution of the king, but the execution of Lavoisier, there is no right measure of values, for Lavoisier was one of the three or four greatest men France has produced.

Since pure science has been preeminent in the past not only in furnishing useful knowledge, but also as a chief foundation of human progress, and is likely to long continue equally preeminent, it is well worth while to study the general principles by which original research is guided. No previous definite study of these principles is known to me, although I have searched not a little to find one. All that I have been able to discover are treatises on logic, the reading of which, most active investigators would, I fear, find tedious and unprofitable rather than helpful and inspiring. We have too many real difficulties to quite enjoy wading through the artificial morass of pedantries, in which logicians by profession embed their significant truths. The stricture is severe, but not too severe even for so sound and valuable a work as Jevons's "Principles of Science." It must be doubted very seriously whether the study of logic is really essential for the right training of an investigator. While it goes without saying that logical thinking is indispensable in science, neither may it be overlooked that thinking is a complicated physiological function, which is brought to efficiency by practise, and that training by actual use is the one indispensable means of disciplining and developing the function. Playing the violin is a complicated physiological function, but it is not thought necessary that the violinist should study the anatomy of the muscles and nerves of the hand and arm. He perfects himself by practise. Anatomical knowledge might enable him to understand why he can make certain motions and can not make others. Our analogy limps perhaps, but is a real analogy, for practise in right thinking creates the necessary habit of being logical, and ability to describe the mental processes in the language of logicians is an accomplishment which few even of the greater scientific discoverers possess.

It is my belief that the logical work of scientific men is usually well done, and is the part of their work which is least faulty. The difficulties and the majority of failures are due, it seems to me, to two chief causes, the first inadequate determination of the premises, the second exaggerated confidence in the conclusions. If I am right, the method of science is the result of the effort to get rid of these two causes of error.

We must recognize in starting that the expression "the method of science" means more than "logic," being far more comprehensive when rightly defined. We can not alter the fundamental conditions of knowledge, for we are still unable to add new senses or improve the brain—although eugenics dreams of a future with such possibilities—nor can we change the nature of the phenomena. The same fundamental resources are available for daily life and for science. We must be clear in our minds on this point, in order to comprehend that the fundamental distinction of the scientific method is its accuracy. As I have said on another occasion "there is nothing to distinguish the scientific method from the methods of every-day life except its precision. It is not a difference in kind or quality, but a quantitative difference, which marks the work of the true scientist and gives its validity." Such being the case, a broad examination of the method of science reduces itself to the

study of the general principles of securing accuracy

If you will examine frankly your own opinions and those of your acquaintance you will, it may be presumed, quickly acknowledge that many, perhaps most, of the opinions are not of scientific accuracy. On the contrary, they are, to a large extent, mental habits and the result of the summation and averaging of impressions. I, for example, know a generous man, but can give very little of the evidence on which my opinion is based. I know a seacoast on which fog occurs in summer quite frequently, yet I can not state how often the fog occurs nor just when I have observed it. At sundry times I have received an impression, in one case of the man's generosity, in the other of fog. The exact data can not be recalled, but the impression on my mind has been fixed by repetition. The evidence is lost, but the conclusions persist and are accepted by me as correct. For my practical needs they are sufficient. We get along in ordinary life satisfactorily enough with opinions thus formed by summation. Most human opinions, even when they are merely imitative, originate in this way, and are correspondingly unreliable. If we seek to explain the fallibility of ordinary opinions and testimony must we not attribute it to the absence of the detailed evidence and the consequent impossibility of verifying the testimony?

We are thus led to recognize the preservation of the evidence as the fundamental characteristic of scientific work, by which it differs radically from the practise of ordinary life. I venture accordingly to define the method of science as the art of making durable trustworthy records of natural phenomena. The definition may seem at first narrow and insufficient, but I hope to convince you that it is so comprehensive as to be not only adequate, but also almost complete.

All science is constructed out of the personal knowledge of individual men. Science is merely the collated record of what single individuals have discovered. Accordingly, we must consider, first, the way in which the individual knowledges are recorded and collated. The process begins, of course, with the publications of the special scientific memoir in which the investigator records his original observations and makes known his conclusions. Permit me to quote from Oldenburg's preface to the first volume of the *Philosophical Transactions of the Royal Society*. The date is 1665.

> Whereas there is nothing more necessary for promoting the improvements of Philosophical Matters, than the communicating to such, as apply their Studies and Endeavours that way, such things as are discovered or put in practice by others; it is therefore thought fit to employ the *Press*, as the most proper way to gratifie those, whose engagement in such Studies, and delight in the advancement of Learning and profitable Discoveries, doth entitle them to the knowledge of what this Kingdom, or other parts of the World, do, from time to time, afford as well of the progress of the Studies, Labours and attempts of the Curious and Learned in things of this kind, as of their compleat Discoveries and performances.

All that he says is true to-day, although our taste has changed in favor of shorter sentences.

It is interesting to note that our present standards for original memoirs have developed gradually. In Harvey's essay on the circulation of the blood, published in 1628, there are no precise data as to his observations. The author does not think it necessary to specify how he has laid bare the heart or how often he has repeated his observations. His descriptions of the beating heart are vividly realistic. He writes with conviction and authority. The reader

is compelled to believe him Harvey, however, does not provide information to facilitate repetition of his work—he offers little aid towards the verification of his results Francesco Redi, the founder of experimental biology, published his "Generation of Insects" in 1660 His experiments proved that insects are not spontaneously generated in putrifying meat. His conclusion[3] is sound, but he does not give more than a general account of the actual experiments A century later Spallanzani established the modern standard, and in his works we find the details as to his evidence put down with scrupulous care, for example in his paper on the circulation (1773) the single experiments are exactly described But Spallanzani in this, as in other respects, was far in advance of his time.

In a cotemporary article we expect a presentation of all the data necessary to render subsequent verification by other observers possible We further expect clear information as to the amount of material on which the observations were made, or the number of experiments on which the work is based In other words, a modern investigator will hardly receive consideration for his researches unless he furnishes every aid he can to facilitate criticizing and testing his results This severe standard has been only gradually evolved, but is now stringently enforced in all departments of science and is the response in our practise to our need of eliminating the purely personal factor It would be advantageous if scientific authors generally viewed the obligation of providing for verification as an even more serious duty than it is esteemed at present. It might, indeed, be a wholesome practise to demand that every scientific article should contain a special section or paragraph on the means of verifying the result, for verification by *Fachgenossen* is second in importance only to discovery in the progress of science

The conditions of scientific progress have changed greatly though very gradually. Two hundred years ago the number of active investigators was small This year there are at least ten thousand men of substantial ability carrying on original researches, consequently each theme is being worked at by several men, and the final outcome is the consequence of collaboration, which is none the less actual and effectual because it is unorganized, and is usually not formally designated as collaboration For example, our present knowledge of the complex and very varied processes of cell-division has been constructed not merely by successive accumulations, but also by incessant debate and repeated mutual criticism. If we examine a paper on mitosis we find not merely the author's own observations, but also references to other related investigations, to specify which there is often a formidable bibliography Within a generation the modern science of bacteriology has been created. Within a few years radiology, the wonders of which still thrill us, has suddenly come into existence Both great achievements are the results of both the original observations and also the constant mutual discussions of a number of scientific men

These conditions have rendered great men somewhat less important than formerly. Science grows by the accretion of ideas. Now, a great man has, let us say, twelve new ideas, where a man of ability has one. If science gets twelve new ideas it matters little whether they come from one man or from twelve. To a certain

[3] At vero ubi loco ita clauso illud (stercorem bovis) dentinui, ut intrare muscae & culices, et ova sua ponere non possent, nihil omnino natum vidi.

extent numbers make a substitute for genius—but nothing probably will ever replace that type of great genius, to which we owe most, the man who has a great thought, which no one has ever conceived before

The nineteenth century in response to the new conditions, which have arisen in its course, has added another new standard for scientific memoirs—they must include a conscientious consideration of recent and cotemporary related work Now the second step in science-making, after recording the new original observations, so as to make them accessible to others, is the collation of these same observations into broad general results The aim is to eliminate the personal factor and to impart the character of impersonal absolute validity to the conclusions

In addition to the original memoirs science profits by a large number of publications, almost all of which are of modern, often of very recent, creation. Broadly speaking, their aim is to promote that collation, which is begun in the original memoirs Germany is the home of most of these undertakings, which are familiar to us under the names of "Jahresberichte," "Centralblatter" and "Ergebnisse" So far as I have learned, Jacob Berzelius's "Jahresberichte" for the physical sciences, which Gmelin translated into German, issuing the first volume at Tübingen in 1822, was the first ancestor, the Adam, of this modern biblic race, which therefore can not yet celebrate its first centenary As concerns those branches of biology known as the medical sciences, the summarizing publications under consideration have become important only since 1870, although they began earlier. For biology 1834 may be taken as the starting point, for it was the initial year of Schmidt's "Jahrbucher der gesammten Medicin" and of Johannes Müller's first Jahresbericht Meckel had just died and Muller assumed the editorship of the *Archiv für Anatomie und Physiologie,* which he conducted for so long that it is still often known simply as Muller's *Archiv,* although the *Archiv* since his death has had several distinguished editors Müller wrote for the *Archiv* the first Jahresbericht entirely himself His report is interlarded with many keen criticisms and even with references to unpublished observations of his own Later he engaged others to assist in the yearly reports, which were kept up until 1857 Their place was taken by Henle's Jahresberichte, which were continued until 1871, when they in turn were replaced by the *Jahresberichte der Anatomie und Physiologie* founded by Franz Hoffmann and Gustav Schwalbe in 1872. The growth of anatomical science is indicated by the fact that in round numbers 400 pages sufficed for the abstracts of anatomical papers in 1872, but 1,500 were necessary in 1908 Similar increases have occurred in the output of the other medical sciences, hence it has become more and more difficult to bring out the Jahresberichte promptly—a delay of two or three years is common To meet this growing difficulty the various Centralblatter have been started—those with which we are here concerned are periodicals issuing small numbers (Hefte) at short intervals and filled with brief abstracts of recently published researches.[3] They have proved of limited utility and their completed volumes are so inconvenient to consult that one

[3] The dates when some of the Centralblätter started are as follows für medizinische Wissenschaften, 1863; für Physiologie, 1887; für Bakteriologie, 1887; für allgemeine Pathologie, 1890; für allgemeine Biologie, 1910 Although the number of German "Centralblätter" is very large, yet in other countries corresponding magazines are viewed with limited favor.

habitually avoids them. They are useful, perhaps, at the moment of publication, but the back volumes encumber rather than enrich our libraries. Fortunately the last decade of the nineteenth century brought us a new and very valuable form of report, the avowed purpose of which is the systematic collation of results. I refer to the "Ergebnisse." The earliest of them known to me was founded in 1892 by Merkel and Bonnet to cover anatomy and embryology. The annual volumes contain essays on various topics which really collate recent discoveries, they differ fundamentally and advantageously in method from the Jahresberichte and Centralblatter, by presenting a combined picture rather than abstracts of single papers. They are substantial contributions to science because they systematize and coordinate the new information. The enterprise of Merkel and Bonnet deserves our most grateful appreciation. Its value is witnessed to by the foundation of similar "Ergebnisse" for other sciences. The series for pathology began in 1896, for physiology in 1902, for zoology in 1909. In the admirable *Revue d'Histologie* (1906) they found a French follower. The "Ergebnisse" are likely to prove of increasing importance and as the number of new investigations mounts higher and higher their comprehensive essays will become even more indispensable than at present.

Although logically more remote from the original sources than the annual and special collations just reviewed, yet handbooks are historically older. Formerly one man could master completely his whole science and keep up with all the new discoveries. In 1834 Johannes Muller wrote the whole annual report upon anatomy, comparative anatomy and physiology, and did it well. A hundred years ago a single author could write a thorough manual. To-day such a feat is impossible. The difficulty has been met with commendable success by cooperation. A science is divided into chapters, each chapter is undertaken by a specialist, and so the task is done, but with consequences easily anticipated, for every one of us knows some of these huge modern composite hand-books.

We recognize in the present methods of recording and collating scientific discoveries many adaptations which are due, it seems to me, essentially to the mere increase in the number of workers. But though the methods are modified the essential steps are the same: *first,* the record of the individual personal knowledge, *second,* the conversion of the personal knowledge by verification and collation into valid impersonal knowledge, *third,* the systematic coordination and condensation of the conclusions.

A defect—perhaps the most serious defect of our education—arises from our failure to make our students appreciate vividly the fundamental fact that science is based on personal knowledge. Our students are allowed to graduate from college, for the most part without any comprehension of this great truth. The best of them start forth with a high reverence for the library, the place of records, but quite unaware that a still higher reverence is due to those who, by being the first to observe unknown things, have founded the knowledge, the records of which the library keeps.

The divergence between philosophy and science shows itself most conspicuously in the personal mental attitude, which philosophy cherishes and science seeks to overcome. Philosophers still discuss philosophers and their systems, scientific men pursue impersonal knowledge with such

ardor that they are apt to know little of the history of science

May I venture to divert your attention to two matters, which suggest themselves in connection with our main theme? The first is the question of style in original scientific articles, for we probably all are ready to admit that the care bestowed on the presentation in print and picture of original discoveries is often insufficient. Do we not all know articles which are bungled in form and weakened by prolixity? Surely the heads of laboratories should insist by example and precept that all the workers under their influence should write clearly and briefly—for if an author fails to show respect for his own scientific work, how can he expect others to respect it? Yet there are few matters so important as intensifying the world's respect for science For us, whose language is English, the standard should be the highest Rivarol in his famous prize essay said "ce que n'est pas clair, n'est pas Français"—but we might say what is not true, is not English By its wealth of synonyms and its logical construction the English language is preeminently adapted to the exact statement of scientific truth. We should not misuse so fine an instrument, which if well employed is sure to win for Anglo-Saxon science the wide influence it deserves Good thinking is the blastema of good style, therefore our learning will never appear good if our learned articles are written badly

The second matter for digression is a suggestion concerning bibliography. Almost every important memoir is accompanied by a bibliography. Custom prescribes it The literature is indicated by the titles in full, and when the list is well made the volume, page and plates are all given Other memoirs on the same subject give similar bibliographies We know from experience that these selected bibliographies are very helpful to those who follow—but is there not a needless waste through frequent repetition? There would be a great economy if we had a complete international catalogue of the scientific literature of each year, in which all the publications of each author were entered with serial numbers It would then suffice to quote an author's name, the year and the serial number, as, for example "John Doe, 1910, 1," to give a complete reference, for it is to be presumed that the catalogue would be found in at least all the principal scientific centers of the world This system has been utilized privately already, and experience with it has demonstrated its eminent practicability and simplicity in use The International Catalogue of the Royal Society, which is at present not only imperfect but excessively inconvenient and really of little use, might be transformed by the plan suggested into an invaluable aid to science The plan could be still more easily applied to the cards of the Concilium Bibliographicum of Zurich It is deplorable that the Royal Society neither cooperates with, nor adopts the system of, the Concilium As matters are the International Catalogue remains merely a respectable failure

To return The records, which we have considered thus far are those which serve to make the discoveries of individuals available for others As soon as the discoveries are properly collated and sufficiently verified they become permanent parts of science Many definitions of science have been given, and did time permit it might be profitable to quote some of them—but is it not sufficient to define science as *knowledge which has acquired impersonal validity?*

We must now attempt a general examination of the records, which are used pri-

marily to help the original investigator, though often preserved to assist his successors. The simplest form of record is the preservation of the actual specimen. Scientific museums are essentially storehouses for such records. Most of them to be sure maintain public exhibitions, which interest, stimulate and possibly instruct the public, but the precious part of their collections comprises the objects possessed, which have served for some original discovery. Scientific museums are very modern, nearly all those in America have been started within a few years. The Philadelphia Academy of Natural Sciences was founded in 1812, the Boston Society of Natural History in 1831, Agassiz's Museum in 1859, the National Museum in Washington in 1876,[4] and the Field Columbian Museum in 1893. A history of museums, dealing especially with the progress of the art of caring for collections would be cheering to read, for it would picture a remarkable growth of the appreciation of the value of objects as original records. This may be illustrated by the change of opinion as to "type" specimens of plants and animals. The systematic zoologists and botanists constantly lament that the earlier authors did not preserve the actual specimens from which they described new species and they consider no pains too great to ensure the preservation of "types" of new species, which any cotemporary worker describes. In the Laboratory of Comparative Anatomy at Harvard we have felt the influence of the example of museums and have established a permanent embryological research collection, a sign of the times and an acknowledgment of the new insistence upon the preservation of the original proofs of discoveries.

[4] The genesis of this museum dates back to Smithson's bequest, 1826, and was in part due to accumulations of materials from various government expeditions before 1876.

The progress of science is marked by the advance in the art of making research records. We all admit, in other words, that the progress of science depends partly on the perfecting of old methods, but chiefly on the invention of new ones. Despite the enormous variety in their nature and aims, all our technical methods have this in common that their real purpose is to yield us records. Our microscopes, spectroscopes, measuring instruments and many another apparatus have indeed their primary scope in rendering possible observations, which are impossible with our unaided senses. They enlarge our field of enquiry and put precision within our reach. Yet their usefulness is conditioned upon their enabling us to make records which else would remain beyond our power. On the other hand, there is a still larger class of apparatus which are obviously designed to make records. What has been said concerning apparatus might be repeated concerning methods.

It is remarkable that the vast majority of methods and apparatus are contrived to furnish a visible result. Sight has long been acknowledged by science as the supreme sense. Perhaps the philosopher was right who asserted that nothing is really known until it is presented in a visible form. We biologists can not deplore too frequently or too emphatically the great mathematical delusion by which men often of very great, if limited, ability have been misled into becoming advocates of an erroneous conception of accuracy. Although I have expressed myself on the subject before its importance justifies recurring to it. The delusion is that no science is accurate until its results can be expressed mathematically. The error comes from the assumption that mathematics can express complex relations. Unfortunately, mathematics have a very limited scope and are

based upon a few extremely rudimentary experiences, which we make as very little children and of which probably no adult has any recollection The fact that from this basis men of genius have evolved wonderful methods of dealing with numerical relations should not blind us to another fact, namely, that the observational basis of mathematics is, psychologically speaking, very minute compared with the observational basis of even a single minor branch of biology Moreover, mathematics can at the utmost deal with only a very few factors and can not give any comprehensive expression of the complex relations with which the biologist has to deal While, therefore, here and there the mathematical methods may aid us, we need a kind and degree of accuracy of which mathematics is absolutely incapable For our accuracy it is necessary often to have a number of data in their correct mutual relations presented to our consciousness at the same time, and this we accomplish by the visual image, which is far more efficient for this service than any other means of which we dispose When we wish to understand a group of complex related details, such as an anatomical structure, we must see them, and if we can not see them no accurate conception of the group can be formed With human minds constituted as they actually are, we can not anticipate that there will ever be a mathematical expression for any organ or even a single cell, although formulæ will continue to be useful for dealing now and then with isolated details Moreover, biologists have to do with variable relations, some of which of course can be put into mathematical form, but we find that even the simplest variations become clearer to us when presented graphically. The value to every student of science of the graphic method has been immense Biologists can work to advantage with quantitative methods, we welcome the increasing use of measurements in biology, we welcome the English journal *Biometrika,* the organ of the measuring biologists—but none the less we refuse to accept the mathematical delusion that the goal of biology is to express its results in grams, meters and seconds. Measurements furnish us with so-called "exact" records, but the aim of science goes beyond the accumulation of exact records to the attainment of accurate knowledge, and the accuracy of our knowledge depends chiefly on what we see The practise of science conforms to this principle, the definite affirmation of which may prove of continuing advantage

No class of records illustrates the value of sight in science more impressively than those made by instruments for registering the time factor The kymographion invented by Carl Ludwig is the prototype of many apparatus In them all a succession of events, like heart beats for example, together with marks showing the time are so registered that they can be seen simultaneously and thus readily compared. If no such apparatus were available much of our most important scientific knowledge would not exist To deprive mankind of microscopes or telescopes would be hardly a more serious blow to science We do not of course depend on our eyes for the notion of time—for the congenitally blind perceive time—but as soon as we wish to know accurately the relation of changing events to time intervals we depend upon having them recorded in a visible form It is the practical acknowledgment of the superiority of the eye as an agent to make clear the correlation of data

When we refer to the history of modern medical science we begin with the anatomist Vesalius, because he reintroduced reli-

ance on seeing in place of reliance on the reading of old authorities.

To dilate longer before this section of the American Association upon the value of seeing is superfluous We have all been trained by dissection and by looking through the microscope, and we will not deny our training, which many of us are engaged in perpetuating.

Scientific records have a far wider scope than ordinary business records, which merely put down details that can not be carried in the memory. Science strives constantly after new ways of recording and demonstrating facts, which would otherwise be imperfectly known, or not known at all, and at the same time of eliminating the personal factor, by getting the data into a form to assist others in the work of verification

Scientific men base their work upon a series of assumptions first, that there is absolute truth, which includes everything we know or shall know, second, that we ourselves are included in this absolute truth, third, that objective existence is real, fourth, that our sensory perception of the objective is different from the reality These conceptions constitute our fundamental maxims, and even when not definitely put in words they guide all sound scientific research Metaphysicians find such maxims interestingly debatable, but science applies them unhesitatingly and is satisfied because their application succeeds Philosophy, ever a laggard and a follower after her swifter sister, has lately and somewhat suddenly termed the scientific habit of work pragmatism and has taken up the discussion of it with delightful liveliness Let us acknowledge the belated compliment and continue on our way

The practical result of the four maxims has been that we further assume that all errors are of individual human origin and that there are no objective errors We make *all* the mistakes, nature makes none. To render the pursuit of new knowledge successful our basic task is to eliminate error, or in other words to decide when we have sufficient proof The elimination of error depends primarily upon insight into the sources of error, which, since methods of all sorts are employed, involves an intimate technical acquaintance with the methods, with just what they can show, with what they can not show and with the misleading results they may produce. In the laboratory training of a young scientific man, one chief endeavor must always be to familiarize him with the good and the bad of the special methods of his branch of science Not until he thoroughly understands the character and extent of both the probable and the possible errors is he qualified to begin independent work His understanding must comprise the three sources of observational error, namely, the variation of the phenomena, the imperfections of the methods and the inaccuracy of the observer. The personal equation always exists, although it can be quantitatively stated only in a small minority of cases

The history of science at large, the history of each branch of science and the personal experience of every active investigator all equally demonstrate that the greatest source of error is in our interpretations of the observations, and this difficulty depends, it seems to me, more than upon any other one factor, upon our unconquerable tendency to let our conclusions exceed the supporting power of the evidence Since generalization is the ultimate goal, we are too easily inveigled into assuming probabilities to be certainties, and into treating theories and even hypotheses as definite conclusions Each generation of investigators in its turn spends

much time killing off and burying older erroneous interpretations The business is seldom accomplished by direct attack, for error perishes only in the light of truth, as microorganisms are said to perish suddenly when struck by ultra-violet rays Owing to the load of false theories, we work like a mental chain-gang and are never unfettered The handicap imposed by wrong hypotheses has always impeded the growth of science Allusion to a few celebrated instances will suffice Phlogiston long prevented chemistry from becoming the peer of other sciences It was a notion which remained alive and dominant until Lavoisier rendered it a mere historical curiosity, by discovering the true principle of combustion The corpuscular theory of light, upheld by Newton, long retarded physics It was got rid of, not by proving it false, but by proving the undulatory theory true. The doctrine of the special creation and fixity of species was universally accepted, although utterly without justification. It vanished from science when the true doctrine of evolution was convincingly established The hypothesis that great epidemics are due to diseases spread by smell, although only the bad guess of ignorance, lasted until modern bacteriology showed us the real causes of infection

The multitude of such experiences, great and small, has gradually created among scientific men a special highly characteristic mental attitude. They regard the majority of the accumulated data and many of the inductions of science as correct This is their estimate of the great body of information which, though personal in its origin, has been in the course of time, so tested and verified that it is looked upon as established and secure. When Asellus in 1622 discovered the lymphatics or so-called lacteals of the mesentery and demonstrated that they convey products of digestion from the intestine, his knowledge was his own, and at first his only. Since then the observations have been so repeatedly verified and of course extended that all uncertainty has vanished from our minds Similarly in innumerable other cases reasonable impersonal certainty has been attained Yet the investigator lives in an atmosphere of concentrated uncertainty, for he is convinced that at any time new data may turn up, and that all generalizations are likely to require modification We might well adopt as our cry—Incredulity towards the known, open credulity towards the unknown.

We think of science as a vast series of approximations and our task is constantly to render our approximations closer to absolute truth, the existence of which we take for granted. We use our approximations as best we may, treating them in large part and at least for the time being as if they were accurately true, yet meanwhile we remain alert to better them This has long been the standard of scientific thought It is the pragmatic attitude of mind, but its new name has not rendered it a novelty

The pivot of all research is adequate proof. It would certainly aid science if some competent philosopher should make a study of the practise of investigators in the various branches of science sufficient to render clear the general principles, by which investigators decide when a new observation or a new induction is sufficiently proven. If we follow the advance of research in any particular direction we soon realize that there is a more or less definite standard of proof, which, though never clearly formulated, is none the less insisted upon, so that any paper which does not come up to this standard is subject to unfavorable criticism Two elements of this

standard we know, the first the elimination of the recognized sources of error, second the repetition of the observations so that the constancy of the phenomenon is assured We can not do more than allude to this theme, which I must leave to the future and to a more competent mind to analyze and develop

To sum up: The method of science is not special or peculiar to it, but only a perfected application of our human resources of observation and reflection—to use the words of von Baer, the greatest embryologist To secure reliability the method of science is *first*, to record everything with which it deals, the phenomena themselves and the inferences of the individual investigators, and to record both truly, *second*, to verify and correlate the personal knowledges until they acquire impersonal validity, which means in other words that the conclusions approximate so closely to the absolute truth that we can be safely and profitably guided by them. The method of science is no mystic process. On the contrary, it is as easily comprehended as it is infinitely difficult to use perfectly and at its best the method supplies merely available approximations to the absolute

We set science upon the throne of imagination, but we have crowned her with modesty, for she is at once the reality of human power and the personification of human fallibility

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THE FORMATION OF CARBOHYDRATES IN THE VEGETABLE KINGDOM[1]

THE classical discovery of Woehler in 1828 first revealed to chemists the possibility of the synthetic production of those compounds which occur naturally in the members of the animal and vegetable kingdoms Woehler himself evidently realized the importance of his discovery. Thus, in a letter to his old teacher, Berzelius, he wrote [2]

> You may remember how, while I was with you, when trying to make ammonia combine with cyanic acid, I always obtained a crystalline body which gave the reactions of neither the one body nor the other I have just made this crystalline body the subject of a little investigation, preparing it by the action of ammonia on lead cyanate and have discovered it to be nothing less than urea

Then he significantly adds, "This may be taken as an artificial production from inorganic substance"

The idea, however, that such compounds could be formed only through the agency of the vital forces of the living organism was one of such long standing and was so deeply established in the popular belief that even the chemists contemporaneous with Woehler were slow to grasp the full significance of the discovery Berzelius himself was evidently not convinced, since in his text-book published in 1837, nine years after Woehler's discovery, he expressed doubt as to the possibility of being able to discover the differences between the causes of reactions in the living organism and those in the inorganic realm. Likewise Gerhardt[3] wrote seven years later (1842) as follows. "I have shown that the chemist works in a way altogether opposite from living nature. The one burns, destroys, operates by analysis Vital force alone operates by synthesis and reconstructs the edifice torn down by chemical forces"

Other discoveries, however, of a nature

[1] Address of the vice-president and chairman of Section C—Chemistry—at the Minneapolis meeting of the American Association for the Advancement of Science.

[2] "Berzelius-Woehler Briefwechsel," I, p 206; Armitage, "A History of Chemistry," p. 143.

[3] *Compt rend*, 15, p 498 Bunge, "Text book of Organic Chemistry," p. 1

similar to Woehler's followed, although somewhat tardily Kolbe in 1845 showed that it was possible to synthesize acetic acid from its elements Berthelot in 1854 likewise built up the fats In the light of such achievements the most skeptical could no longer maintain the old view concerning the impossibility of building up in the laboratory from inorganic sources those compounds naturally occurring in the living organism The recognition of this great truth opened up to chemists a new line of investigation and from that time the synthetic preparation of organic compounds has ever been a fruitful field of research It has sometimes seemed to me, however, that in the enthusiasm over the discoveries which chemists have made in this field of investigation we are inclined to over-estimate the work done, great as that may be, and perhaps unintentionally convey the impression that the chemical changes taking place in the living organism are thoroughly understood and can be duplicated in the laboratory While of course it is true that many of the compounds in the living organism have been synthesized and that the number of such syntheses is constantly increasing, yet we must not forget that the chemist's method has never been, in detail at least, the method of nature Indeed, as a rule they are widely divergent We are apt to employ powerful reagents many of which so far as is known do not exist in the organism nor in the mediums from which it draws its sustenance The drastic treatment to which these substances are often subjected and the temperatures at which the reactions are carried on are all in the greatest contrast to the conditions which prevail in the organism in which the natural synthesis is effected In a few cases the laboratory methods employed more nearly approach the conditions which prevail in nature and such syntheses always have a greatly added interest at least from a theoretical standpoint Thus the observation of Loew[4] that a sugar-like compound could be formed by the condensation of formaldehyde was exceedingly important, but this importance was greatly enhanced by the fact that this condensation could be effected by the action of mild alkalis or even neutral substances at ordinary temperatures—conditions which approximate those existing in the growing plant Likewise the importance of the observations of Lobry de Bruyn and van Ekenstein[5] that the three hexoses, namely, mannose, fructose and dextrose, are mutually convertible, lay largely in the fact that these transformations could be made to take place at ordinary temperatures under the influence of reagents that may exist in the soil The study of such problems as these has become not only one of the most alluring and fascinating in the fields of research in organic chemistry, but their solution is fraught with the greatest significance, since it will be a step in the direction of gaining some understanding of the mysteries of life itself

Inasmuch as the carbohydrates play such an important part in the economy of the vegetable kingdom, it is quite natural that the investigations of the problems pertaining to the synthesis of compounds in the living organisms have been largely directed towards this class of compounds. Since it is impossible in a short time to discuss with any thoroughness the various researches carried out in this field of investigation I will confine myself to those which have some important bearing upon the well-known hypothesis proposed by Baeyer, with a view of determining, if pos-

[4] *J prakt Chem*, 33, p 321.

[5] *Ber. d chem Gesell*, 28, p. 3078

sible, its standing in the light of modern discoveries.

In 1861 there appeared in the *Annalen der Chemie* and simultaneously in the *Comptes rendus* a short article by a Russian chemist, Butlerow,[6] in which he described the formation of a sugar-like substance (methylenitan, he termed it) through the interaction of trioxymethylene and calcium hydroxide in an aqueous solution. Although the resulting substance was optically inactive and was not fermentable, Butlerow nevertheless was sure that the sweet syrup which he obtained contained a sugar, for he concludes his accounts with the statement that his results furnish the first example of the synthesis of a sugar-like body. These results of Butlerow proved to be of the greatest importance, not only because of the facts revealed, but also because they served to suggest to other investigators the method of attacking the general problem of the synthetic production of sugars. Moreover, they undoubtedly served as an experimental groundwork upon which Baeyer a few years later based his well-known hypothesis.

The essential assumptions of Baeyer's hypothesis, viz., the production of formaldehyde through the interaction of carbon dioxide and water, and the subsequent polymerization of this to a sugar, are well known to all and require no discussion. It may be of interest, however, to recall some of the reasons advanced by Baeyer in setting forth these assumptions.

The original statement of the theory was published in the *Berichte* just forty years ago (1870) and was entitled "Ueber die Wasserentziehung und ihre Bedeutung fur das Pflanzenleben un die Gahrung."[7]

[6] *Annalen der Chem.*, 120, p. 295; *Compt. rend.*, 53, p. 145.

[7] *Ber. d. chem. Gesell.*, 3, p. 67.

Baeyer here calls attention to the fact that in the transformation of the compounds of carbon, hydrogen and oxygen, the separation of water plays just as weighty a rôle as do the processes of oxidation and reduction. He then discusses the groups of those reactions in which water is formed by the union of hydrogen and oxygen withdrawn from the interacting compounds. Among the various reactions are those in which the water removed is formed by the union of hydrogen taken from one molecule with an hydroxyl group taken from a different molecule—an "*aussere Condensation*," as Baeyer termed it. To illustrate this he gives his interpretation of the reaction involved in Butlerow's sugar synthesis. Although Butlerow had used trioxymethylene, Baeyer evidently felt justified, because of the intimate relation between this compound and formaldehyde, in assuming that the reaction actually taking place is one between the different molecules of formaldehyde. Considering that formaldehyde in aqueous solution is in the hydrated form, Baeyer shows that by the splitting off of water formed by the union of a hydroxyl group from one molecule of formaldehyde with the hydrogen from another molecule and the union of the two remaining residues through the resulting free affinities, it is easy to understand how from six molecules of formaldehyde the hexoses might result. Baeyer even deduced two possible structural formulas for a hexose based on this interpretation of the course of the reaction, one of these being the well-known aldehyde formula. Likewise he shows how by the condensation of three molecules of formaldehyde one would expect to obtain an aldehyde of glyceric acid. The older view of Liebig to the effect that the fruit acids are the intermediate products from which the sugars result, Baeyer rejects in favor of

the one that the sugars are formed directly from the carbonic acid. This formation could be satisfactorily accounted for as follows. Through the combined action of chlorophyll and sunlight carbon dioxide suffers dissociation into carbon monoxide and oxygen. The oxygen is evolved while the carbon monoxide combines with the chlorophyll much as it does with the hæmoglobin of the blood. By the action of hydrogen, obtained by the dissociation of water, the carbon monoxide is then changed into formaldehyde from which the sugar results by condensation. The essential points in Baeyer's hypothesis are therefore, first, the production of formaldehyde from carbon dioxide and water, and second, the formation of sugars by the polymerization of the aldehyde. Other investigators have suggested certain modifications of this theory, mainly in the method of generation of the formaldehyde. Thus, Erlenmeyer[8] in 1877 from certain observations made on the action of water on hydroxy acids was led to conclude that the carbonic acid would be acted upon by water under the conditions existing in the plant with the production of formic acid and hydrogen peroxide in accordance with the following equation: $HO.COOH + HOH \rightarrow H_2O_2 + H.COOH$. The formaldehyde would then result from the reduction of the formic acid. Bach,[9] on the other hand, assumes the decomposition of the carbonic acid directly into formaldehyde and an unstable percarbonic acid, H_2CO_4, which would break down into hydrogen peroxide with regeneration of carbon dioxide. Usher and Priestley[10] as well as Pollacci[11] have also suggested certain modifications of the general assumptions.

[8] *Ber. d. chem. Gesell.*, 10, p. 634.

[9] *Compt. rend.*, 116, pp. 1145, 1389; 126, p. 479.

[10] *Proc. Royal Soc.*, B, 77, p. 369; 78, p. 318.

[11] *Bot. Zentralbl.* for 1904 and 1905.

The principal researches which have a direct bearing on the validity of Baeyer's hypothesis may be classified in regard to their bearing on the following problems: First, Is it possible to produce formaldehyde in the laboratory from carbon dioxide and water under conditions approximating those existing in the plant? Second, Is formaldehyde actually present in the living organism? Third, Is it possible for the organism to assimilate formaldehyde? Fourth, Is it possible to produce carbohydrates directly from formaldehyde?

It is my purpose to discuss briefly the more important researches carried out in these fields of investigation.

PRODUCTION OF FORMALDEHYDE THROUGH THE REDUCTION OF CARBONIC ACID

The production of formaldehyde through the reduction of water and carbon dioxide has been the subject of numerous researches. Maly[12] in 1865, and in more recent time Lieben[13] (1895), attempted this reduction by employing various amalgams as reducing agents. Royer[14] in 1870 and Coehn and Jahn[15] in 1904, on the other hand, studied the effect of electrolytic hydrogen on the carbonic acid. In all these cases, however, the reduction resulted not in the formation of formaldehyde, but of formic acid. In 1893 Bach[16] attempted to carry out the reaction under conditions closely approximating those existing in the plant. As a substitute for the chlorophyll in the plant Bach, relying upon the well-known sensitiveness of uranium compounds to light, used uranium acetate as a chemical and photo-sensitizer. Carbon dioxide was passed through flasks filled

[12] *Annalen der Chem.*, 135, p. 119.

[13] *Wien. Monats.*, 16, p. 211; 18, p. 582.

[14] *Compt. rend.*, 70, p. 731.

[15] *Ber. d. chem. Gesell.*, 37, p. 2836.

[16] *Compt. rend.*, 116, pp. 1145, 1389.

with a 1.5 per cent solution of uranium acetate. When the experiment was carried out in the sunlight there was obtained a precipitate of the hydroxides of uranium together with a small amount of peroxide. The results are explained on the supposition that the carbonic acid is resolved into formaldehyde and a percarbonic acid, H_2CO_4, in accordance with the following equation: $3H_2CO_3 = CH_2O + 2H_2CO_4$. The percarbonic acid as fast as formed breaks down into hydrogen peroxide and carbon dioxide. To support this interpretation of the course of the reaction, Bach refers to the work of Wurster,[17] who claimed to have demonstrated the presence of hydrogen peroxide in plants, although Wurster's results had been strongly challenged by Bokorny.[18] In 1898 Bach[19] again returned to the problem, this time using palladium as a catalyzer. Carbon dioxide was passed through water containing palladium held in suspension. In the clear liquid obtained by filtering off the palladium Bach claims to have established the presence of formaldehyde.

While the experiments of Bach are ingeniously conceived and are of great interest, his interpretation of the results do not appeal to one as at all conclusive. The most that can be said is that the generation of formaldehyde and hydrogen peroxide under the conditions of the experiments is probable. Their presence must be regarded as inferred rather than proved. It is not strange therefore that his results have been criticized. In 1904 Euler[20] repeated the work and concluded that the carbon dioxide in Bach's experiments did not enter into the reaction at all since exactly the same results are obtained if one substitutes a current of hydrogen or nitrogen for the carbon dioxide.

On the other hand, Usher and Priestley[21] in 1906 reported that "the experiments of Bach have been repeated and confirmed, both as to the production of peroxide and formaldehyde." Oddly enough, however, they gave no account as to their manner of confirming these results, and since Bach himself rather inferred than proved the presence of these two compounds the statement of Usher and Priestley is not wholly satisfactory. In order to meet the criticism that the production of formaldehyde in Bach's experiments may have resulted from the reduction of the acetic acid which would undoubtedly be formed by the hydrolysis of the uranium acetate used, Usher and Priestley[22] in a later article described a series of experiments in which uranium sulphate was substituted for the uranium acetate. In these experiments no formaldehyde could be detected, although the authors report that "a study of the reactions involved favors the view that it is formed as a transitory intermediate product." In their original work Usher and Priestley were led to conclude from experiments on plants (*Elodea* were used) that the generation of formaldehyde in the plant from carbon dioxide and water is not a vital process at all since small plants of *Elodea* in which all life had been destroyed by immersion in boiling water accumulated perceptible amounts of formaldehyde when exposed to sunlight in a moist atmosphere of carbon dioxide. The tests for formaldehyde were made directly upon the leaves as well as upon the distillate from the leaves. The principal tests employed were (*a*) the development of color in Schiff's reagent, (*b*) the formation of methyleneaniline with

[17] *Ber. d. chem. Gesell.*, 19, p. 3195.
[18] *Ber. d. chem. Gesell.*, 21, p. 1100.
[19] *Compt. rend.*, 126, p. 479.
[20] *Ber. d. chem. Gesell.*, 37, p. 3411.
[21] *Proc. Royal Soc.*, B, 77, p. 370.
[22] *Proc. Royal Soc.*, B, 78, p. 318.

aniline, and (c) the formation of hexamethylene tetramine with ammonia and bromine Acting on the conclusion that the production of formaldehyde in the plant is not a vital process, these investigators in a later article described a series of experiments in which they attempted to produce formaldehyde from water and carbon dioxide in the laboratory by reproducing the conditions existing in the plant Plates of glass were painted over with gelatine, which in turn was coated with a thin film of chlorophyll The plates so prepared were placed in a moist atmosphere of carbon dioxide and exposed to the sunlight The chlorophyll was employed to effect a reduction of the carbon dioxide and water into formaldehyde by acting as a photo-sensitizer, while the gelatine was used in the hope that it would absorb all formaldehyde as fast as formed, thus removing it from the sphere of action After the exposure of the plate the gelatine was removed and tested for formaldehyde by the tests previously mentioned and in all cases the aldehyde was found to be present

If the interpretation of these results, as given by Usher and Priestley, is correct, this work is of the very highest value, not only in its relation to Baeyer's hypothesis, but especially because the reduction of carbon dioxide and water to formaldehyde in plants is shown to be a laboratory and not a vital process It must be stated, however, that the conclusions reached have been contradicted by Ewart,[23] who insists that the gelatine used in the experiments will give the test for formaldehyde just as well before exposure to carbon dioxide and light as after such exposure, and that even granting the generation of formaldehyde under these conditions, it is, to say the least, just as reasonable to conclude that it is derived from the decomposition of the chlorophyll in the presence of oxygen as it is to conclude that it is formed from carbon dioxide and water

Some of the most interesting results in this field of investigation have been obtained by Lob,[24] who attempted to gain some insight into the changes taking place in the plant by substituting the action of the silent electric discharge for that of the sunlight as well as of any catalytic agent or enzyme present in the plant In this way it was shown that formaldehyde is a direct reduction product of carbon dioxide and water vapor Lob claims, and with justice, that his experiments bring the first positive proof that formaldehyde is a direct reaction product of moist carbon dioxide

In 1907 Fenton[25] attempted the generation of formaldehyde directly from carbonic acid by passing a current of carbon dioxide for a number of hours through pure water in contact with several rods of amalgamated magnesium He concludes that "the solution gives slight but unmistakable indications of formaldehyde" with certain standard color tests So far as I know, these results have not been challenged

The most recent work, as well as probably the most significant, is that of Berthelot and Gaudechon[26] By the action of ultra-violet light on a mixture of carbon dioxide and water vapor, these investigators have succeeded in obtaining formaldehyde together with carbon monoxide and oxygen. Under the same conditions, carbon monoxide and water vapor gives rise to formaldehyde, carbon dioxide and hydrogen.

[23] *Proc Royal Soc*, B, 80, p 30

[24] *Zeit. f Elektrochem*, 12, p 282

[25] *J L Chem Soc*, 91, p 687

[26] *Compt. rend*, 150, p 1690.

THE EXISTENCE OF FORMALDEHYDE IN PLANTS

As an immediate result of Baeyer's hypothesis attempts have been made to detect formaldehyde in plants of various species and grown under various conditions The results of these investigations are not at all satisfactory and indeed consist largely in affirmations and denials The problem, however, is not a simple one In the first place formaldehyde, if present at all, can only be present in very minute quantities because of its very great toxicity, and while it is true that extremely delicate tests have been advanced for formaldehyde it is likewise true that these tests have been subjected to considerable criticism. Moreover, it is possible that such delicate tests might be influenced by the presence of various other substances present in the plant

In 1881 Loew and Bokorny[27] advanced the theory that the vital force of the living protoplasm is essentially connected with the presence of aldehyde groups in the substance forming the protoplasm When certain algæ, for example, were immersed in a dilute solution of silver nitrate the living cells were found to be darkened when examined under the microscope The authors attribute this change in color to the reduction of the silver salt by the aldehyde present Plants previously immersed in boiling water to destroy the life of the protoplasm failed to give the test, hence the authors conclude that the aldehyde group disappears with the life of the plant

In the same year Reinke[28] by macerating certain green leaves (those of the grape vine, the poplar, the willow and conifers, were tested) and distilling the mass in a current of steam obtained a liquid having strong reducing powers which he attributed to the presence of an aldehyde Moreover, the aldehyde must be an easily volatile one, for it is present chiefly in the first portions of the distillate While not able to prove the exact identity of the aldehyde Reinke concluded that it is formaldehyde These reactions were obtained only in the case of chlorophyll-bearing plants Reinke suggested that the reducing power of the algæ observed by Loew and Bokorny might be due to the presence of formaldehyde in the plant This statement led to further studies by both investigators and the publication of several articles[29] in which each held to his original interpretation of the results, although Reinke was forced to admit that he had not definitely proved the presence of formaldehyde in the distillate from the plants, but only the presence of an easily volatile aldehyde

Mori[30] (1882) experimenting with the leaves of the rose bush and of oats obtained results similar to those of Reinke He also tested the plant by adding a few drops of Schiff's reagent directly to portions of the plant, whereupon a red color gradually resulted Loew and Bokorny[31] claim, however, that the development of the color in Mori's experiments was due to the evaporation of the sulphurous acid in Schiff's reagent and show that this reagent gradually becomes colored by mere exposure to air

In 1889 Polacci[32] reported the results of an extended series of investigations from

[27] *Arch. ges Physiol.* (*Pflügers*), 25, p. 150.

[28] *Ber. d chem Gesell*, 14, p. 2144.

[29] *Bot Zeit.*, 1882, No. 40, *Ber. d. bot Gesell*, 16, p 201; 17, p. 7; *Ber d. chem Gesell*, 15, pp 107, 695; "Studien über das Protoplasma," zweite Folge, Berlin, 1883.

[30] *Nuovo. Gio Bot Ital.*, 14, p 147

[31] *Bot. Zeit*, 1882, p. 832; *Arch. ges. Physiol.* (*Pflügers*), 26, p 50.

[32] *Atti d. Inst. Bot. d. Univ. d. Pavia*, II., Serie 7, 1.

which he concluded that formaldehyde is undoubtedly present in the green parts of living plants when exposed to sunlight He experimented directly with the growing plant, as well as with the liquid obtained by distilling the leaves in a current of steam Twigs were bent down from the growing plant into cylinders containing Schiff's reagent It was found that when the experiment was carried on in the sunlight the red color gradually developed, which result was attributed by the investigator to the production of formaldehyde While the results obtained by the tests made directly upon the leaves were only suggestive and not conclusive, the distillate from the leaves Polacci affirms undoubtedly contains formaldehyde itself Many tests were employed Some of these were of a general character, while others were definite for formaldehyde itself Special stress is placed on (*a*) the color test obtained by successive additions of phenylhydrazine, nitroprussiate of sodium and alkali, (*b*) the color test with sulphuric acid and codeine, (*c*) Trillat's color test with an aqueous solution of dimethyl aniline in the presence of acetic acid and lead peroxide, (*d*) the reaction with phenylhydrazine, (*e*) the color test with phenol and sulphuric acid A short time after the publication of the results of Polacci's experiments two other Italian investigators, namely Plancher and Ravenna,[33] reported a series of similar experiments, but failed to find any conclusive proof of the presence of formaldehyde in plants The formation of color in Schiff's solution under the conditions of Polacci's experiment was attributed not to the presence of formaldehyde, but to the "active" oxygen evolved by the plant in the process of assimilation They likewise claimed that the tests which Polacci employed for the detection of formaldehyde in the distillate from green leaves are untrustworthy In order to determine whether formaldehyde, if present in the green leaves, would actually distill over or would remain combined with compounds in the plants, these investigators added a very dilute solution of formaldehyde to leaves before distillation and then tested for formaldehyde in the distillate The results showed that the amount of formaldehyde which must be present in the leaves in order to respond to conclusive tests in the distillate is so large that it would destroy at once the vitality of the plants. Polacci's results have also been criticized by Czapeck[34] as being indefinite Euler,[35] on the other hand, confirms his results, although he expresses the opinion that the formaldehyde is not present in a free state in the plant, but is liberated from its condensation products by the process of distillation. In a more recent article Polacci[36] refers to the criticisms of his investigations and defends his original conclusions with great vigor

Among the other investigators may be mentioned Grafe[37] as well as Kimpflin,[38] both of whom maintain that formaldehyde is undoubtedly present in the growing plant The former investigator used a solution of diphenylamine in sulphuric acid as a test, claiming that this reagent gives a green coloration with exceedingly minute quantities of the aldehyde. Kimpflin, on the other hand, recognizing that formaldehyde, if present at all, can only be present in minimal amounts, ingeniously attempts to store up the compound as fast as formed until a sufficient quantity is obtained to respond to the tests. To do

[33] *Atti d Real Accad d Lincei*, 13, p 459.

[34] *Bot Zeit*, 1900, p. 159

[35] *Ber d chem. Gesell*, 37, p 3411

[36] *Atti d Real. Accad d Lincei*, 16, p 199.

[37] *Oesterreich bot Zeitschrift*, 1906, No 9

[38] *Compt rend.*, 144, p 148

this he introduces into the tissue by means of a capillary tube a solution of sodium acid sulphite and methylparamidometacresol. After this injection the plant is exposed to the light for a time, when a section of the leaf is placed in absolute alcohol and subsequently examined under the microscope in the presence of a drop of water The presence of the aldehyde is shown by the formation of a red color. According to the author, the aldehyde as fast as produced combines with the acid sulphite to form the addition compound which is stable in the absolute alcohol. Upon the addition of a drop of water, however, the aldehyde is liberated and forms a characteristic color with the cresol.

While Usher and Priestley[39] claim to have definitely proved the presence of formaldehyde in the dead plant according to the method described above, they merely infer its presence in the living plant In fact, they assert that it would be useless to look for it in a healthy living plant because of the rapidity with which it would be transformed into other substances

In a recent article Bokorny[40] criticizes the work of Kimpflin and others and maintains that the amount of formaldehyde which would have to be present in the plant in order to respond to any of the known tests would certainly destroy the vitality of the plant He maintains, however, that it is undoubtedly present, but in such minute quantities at any given period that the only hope for its detection lies in the discovery of some agent which would combine with the aldehyde as fast as generated to form a compound that is not toxic to the plant and from which compound it could again be recovered in quantities sufficient to respond to the standard tests It may be added that this is practically what Kimpflin attempted.

[39] *Proc. Royal Soc.*, B, 77, p 370

[40] *Arch ges. Physiol (Pflügers)*, 125, p 484

THE ASSIMILATION OF FORMALDEHYDE BY PLANTS

No single evidence perhaps would count so much towards corroborating Baeyer's hypothesis as the proof of the power of plants to assimilate free formaldehyde with the production of carbohydrates It is natural therefore that many experiments have been made to ascertain just what effect formaldehyde has on the growing plant In conducting such experiments naturally the formaldehyde would have to be administered in very dilute solutions, moreover, the amount of such solutions would have to be large in order to obtain a sufficient amount of formaldehyde to effect a sensible amount of any assimilation product

The first investigator to make any extensive study of this question was Bokorny,[41] who attempted to grow certain water plants (green filaments of *Spirogyra*) in dilute solutions of formaldehyde. He found that formaldehyde, even in solutions of 1 to 50,000, was fatal to the growth of the plant Next the attempt was made to substitute for the free formaldehyde some substance which under the influence of the plant would slowly decompose, giving formaldehyde as one of the decomposition products Such a substance Bokorny found in methylal which decomposes into formaldehyde and methyl alcohol and also in the sodium acid sulphite addition product of formaldehyde By the use of these compounds Bokorny hoped to diminish the concentration of the actual aldehyde to the minimum and yet by its constant formation furnish a sufficient amount of it to

[41] *Ber d. bot Gesell*, 1888, p 119; *Chem. Zeit*, 44, p 525; *Phar. Post*, 36, p 153; *Biolog. Centralbl*, 12, No. 16 and 17.

the plant to enable one to prove whether or not assimilation actually takes place. It was found that the *Spirogyra* immersed in a solution of either of these substances under certain conditions continue to grow and produce starch in the absence of carbon dioxide These results must be regarded as strong corroborative evidence in favor of the view that plants have the power of directly assimilating formaldehyde, they are not conclusive, however, since there is no actual proof that the compounds are decomposed by the plants previous to assimilation

Later Bouillac and Giustiniana[42] succeeded in growing ordinary white mustard in solutions containing traces of formaldehyde It is interesting to note that a certain amount of light was necessary, however, for the growth of the plant

Treboux[43] also reports that he has successfully grown the *Elodea* in solutions of one part of formaldehyde in one hundred thousand, but that no starch was formed; hence he concludes that his results are opposed to the general belief that formaldehyde is directly polymerized to carbohydrates

Usher and Priestley[44] in the investigations referred to above likewise report a case of starch formation in a solution containing one part of formaldehyde in one hundred thousand

In 1908 Bokorny[45] reported some experiments in which he succeeded in proving that spirogyra can assimilate such substances as glycerol, sucrose and even traces of formaldehyde itself when present in dilute solutions A year later[46] he again reported some experiments in which he attempted to grow water cress under a bell jar over a 30 per cent solution of sodium hydroxide containing small amounts of formaldehyde and concludes that the upper portions of the plant undoubtedly absorb aldehyde vapor This assimilation can take place in the absence of both oxygen and light

Likewise Grafe and Vieser[47] have grown seedlings of *Phaseolus vulgaris* in air free from carbon dioxide but containing formaldehyde and report that plants under such conditions grow more rapidly than in normal air

So far as I know, no attempts have been made to ascertain the effect of glycolaldehyde and glycerose upon the growth of the plant It is probable that these compounds are intermediate products in the formation of a sugar by the polymerization of formaldehyde One would naturally expect therefore that they would be assimilated by the growing plant Moreover, they would be better adapted than formaldehyde for such investigations, since they are relatively less toxic, and hence could be used in larger amounts.

SYNTHETIC PRODUCTION OF SUGAR FROM FORMALDEHYDE

It will be recalled that Butlerow's methylenitan was synthesized not from formaldehyde itself but from a closely related compound, trioxymethylene Loew[48] in 1886 was the first to build up a sugar directly from formaldehyde, using mild alkalis as condensing agents. Three years later Loew[49] succeeded in obtaining a purer product (formose) by using the oxides of lead and magnesium as condensing agents. In the meanwhile Fischer[50] was carrying out those brilliant researches in which the

[42] *Compt rend*, 136, p 1155

[43] "Flora," 92, p 73

[44] *Proc Royal Soc*, B, 77, p. 370

[45] *Arch ges Physiol (Pflügers)*, 125, p 467.

[46] *Arch ges Physiol (Pflügers)*, 128, p. 565

[47] *Ber d bot Gesell*, 27, p. 431

[48] *J prakt Chem*, 33, p. 321

[49] *Ber. d chem Gesell.*, 22, p 475

[50] *Ber d chem Gesell*, 20, pp. 1093, 2566, 3384

synthesis of fructose was effected first from acrolein and later from glycerol. The whole subject of the action of alkalis upon formaldehyde has been taken up in recent years by Euler,[51] who has made a careful study of the course of the reaction and the conditions affecting it It is especially interesting to note that this investigator has succeeded in synthesizing a sugar from formaldehyde through the agency of calcium carbonate as a condensing agent The interest here lies chiefly in the fact that the formation of sugar may be effected by a substance universally distributed in the soil It is interesting to note that Euler in this way showed that the simplest of sugars, viz., glycolaldehyde, is produced as an intermediate product The principal sugar finally formed is a pentose, namely, (*dl*)-arabino-ketose Lob[52] has recently effected similar condensations by the use of zinc as well as zinc carbonate.

Equally important are the results which have been obtained through the action of the silent electric discharge Berthelot,[53] in this way, produced from a mixture of carbon dioxide, water and hydrogen a substance having the properties of a carbohydrate With carbon monoxide and hydrogen he obtained a similar product which appeared to be a polymer of formaldehyde. Likewise Slosse,[54] from carbon monoxide and hydrogen, obtained a crystalline, fermentable sugar

The investigations of Lob[55] in which he produced formaldehyde directly from carbon dioxide and water vapor through the influence of the silent electric discharge have already been referred to. Under the same conditions this investigator has been able to polymerize the aldehyde so formed into glycolaldehyde and this in turn into a hexose The formation of a sugar from carbon dioxide and moisture has thus been effected through the agency of the energy of the silent electric discharge. It may be added that patents have been taken out for the synthetic production of sugar under this general method

Taken as a whole, the results of the investigations would seem to corroborate Baeyer's original assumptions The transformation of carbon dioxide and water into formaldehyde and the subsequent polymerization of this into a sugar under conditions approximating those existing in the plant may be regarded as accomplished While the evidence advanced can not be regarded as showing beyond doubt the presence of free formaldehyde in the plant, yet it is plain that the failure to detect its presence can not be regarded as fatal or as even opposed to Baeyer's theory In fact, one would naturally expect that because of its great activity, its polymerization would keep pace with its formation and that the tests for its presence would therefore be negative On the other hand, it can not be doubted but that plants have the power to directly assimilate formaldehyde While certain objections have been urged against Baeyer's hypothesis and other radically different ones[56] have been advanced, yet it would seem from the present indications that further progress in our knowledge of the formation of carbohydrates in the vegetable kingdom probably will be made along the lines originally pointed out by Baeyer

In the study of the results of these investigations one is impressed with the large number of conflicting statements Certainly one would not turn to these re-

[51] *Ber. d. chem Gesell*, 39, pp 39, 45

[52] *Biochem Zeit*, 12, p 78.

[53] *Compt rend*, 126, p 610.

[54] *Bull. de l Ac roy de Belg*, 35, p 547

[55] *Zeit f Elektrochem*, 12, p 282.

[56] Etard, "La Biochem. et les chlorophylles," Paris, 1906; Loew, "Chem. Energ in leb. Zell," 1906.

ports as an argument for the exactness of chemical science As a rule, however, the disagreements relate not so much to the observations as to their interpretation Of course it is useless to expect investigators to agree upon the question as to whether or not formaldehyde is present in the plant, until they first can agree in regard to the tests for formaldehyde which shall be considered as conclusive Again while this general subject is primarily a chemical one, yet many of the investigators have been men trained rather in other fields of work It would seem that the chemist, or better, perhaps, the chemist and the botanist working conjointly, ought to be able to make surer progress in such investigations The problem is an exceedingly complex one. Its solution involves many reactions at present but little understood—such as the nature of catalytic and enzymic action and the formation of asymmetric compounds It is probable also that other forces not yet investigated may enter into the reactions by which these compounds are formed Stewart[57] has even suggested that it is "not improbable that the rotation of the earth or terrestrial magnetism or the motion of the earth around the sun may have some effect" There is no doubt, however, but that progress is being made It is also undoubtedly true that many of the researches now being carried on in our laboratories will be found to have a more or less direct bearing upon the general question; and it has been partly my object in discussing this topic to emphasize this fact in order that the results of our investigations, whenever applicable, may be directed towards the solution of this problem

WILLIAM McPHERSON
OHIO STATE UNIVERSITY

[57] "Stereochemistry," London, 1907, p 535.

THE AMERICAN MUSEUM OF NATURAL HISTORY

DR HERMON C BUMPUS has resigned the directorship of the American Museum of Natural History and has accepted the position of business manager to the University of Wisconsin This announcement was made on January 20 by Mr. Seth Low, chairman of a special committee of the trustees appointed to consider the administration of the museum He gave out the following statement

Director Bumpus notified the trustees of the American Museum of Natural History at a special meeting held yesterday afternoon that he had accepted an appointment as business manager for the University of Wisconsin Accordingly he presented his resignation as director, which was accepted The administrative difficulty in the museum is thus terminated

The questions raised as to the respective duty and authority of various officers in the museum seemed to the board important enough to be referred to a special committee, which was appointed on November 30, 1910, to give a hearing to the director and to consider his criticisms The committee, which consisted of Anson W Hard, Adrian Iselin, Jr, Percy R Pyne, Felix M Warburg and Seth Low (chairman), went into every criticism very thoroughly They found nothing to justify the sweeping statements which had been made, and the specific criticisms of President Osborn, when sifted, were found to be either unimportant or not sustained The committee and the board believes that the administration of President Osborn has been wise, efficient, far sighted and public-spirited, and that the financial management has been sound and constructive

THE CARNEGIE INSTITUTION OF WASHINGTON

IT was announced on January 20 that Mr Andrew Carnegie had added $10,000,000 to the endowment fund of the Carnegie Institution of Washington. The institution was established in 1902 with a gift of $10,000,000, and Mr Carnegie recently added $2,000,000 These gifts consist of preferred bonds of the Steel Corporation bearing five per cent. interest and their market value is considerably above their par value Mr Carnegie's gifts to

public purposes now amount to about $200,000,000.

SCIENTIFIC NOTES AND NEWS

At its last meeting the Rumford Committee of the American Academy of Arts and Sciences made the following grants: To Professor Joel Stebbins, of the University of Illinois, $200, in further aid of his researches on the selenium photometer. To Professor M. A. Rosanoff, of Clark University, $300, in further aid of his investigation on the fractional distillation of binary mixtures.

The Society of American Bacteriologists will meet in Washington, D. C., the last week in December of this year. The officers are: *President,* F. P. Gorham, Brown University; *Secretary,* Charles E. Marshall, Michigan Agricultural College.

At the annual meeting of the New York Pathological Society, held at the Academy of Medicine, on January 11, the following officers were elected: *President,* Dr. William G. MacCallum; *Vice-president,* Dr. John H. Larkin; *Secretary and Editor,* Dr. A. M. Pappenheimer; *Treasurer,* Dr. Francis C. Wood. Dr. T. M. Prudden and Dr. E. K. Dunham were reelected trustees of the society to serve for a term of three years. The next meeting will be held in conjunction with the Philadelphia Pathological Society in Philadelphia on February 9.

Mr. S. P. Jones, formerly assistant state geologist of Georgia, is with the New Jersey Geological Survey.

Mr. C. E. Bradley has resigned as chemist of the Agricultural Experiment Station at Corvallis, Oregon, to accept the position of research chemist with the Rubber Regenerating Company, of Mishawaka, Indiana.

The program of the Section of Astronomy, Physics and Chemistry of the New York Academy of Sciences on January 27 included the following papers on Aviation: "Experiences in Aviation," Mr. Clifford B. Harmon; "Practical Utility of Flying Machines," Mr. Hudson Maxim; "The Aeroplane" (illustrated by lantern slides), Lieutenant Phillip Wilcox, U. S. A. R.; "Taking the First Photographs of the Flights of the Wright Brothers at Kitty Hawk, North Carolina" (illustrated by lantern slides), Mr. James H. Hare.

Professor W. P. Mason, of Rensselaer Polytechnic Institute, delivered a lecture before the Williams College Natural Science Club on "Water and Disease," on January 19.

The Smithsonian Institution is about to come into possession of a bequest by the recent death of George W. Poore, Esq., of Lowell, Mass. His will provides, after certain minor legacies, that the residue of his estate be given to the Smithsonian Institution to form the Lucy T. and George W. Poore Fund, the income of which is to be used for the purposes for which the institution was founded. The will further requires that this fund shall be kept separate from all other funds and the income to be added to the principal until it shall have reached the sum of $250,000. Mr. Poore explains in his will that he makes this bequest in the hope that "it will form an example for other Americans to follow by supporting and encouraging so wise and beneficent an institution as I believe the Smithsonian Institution to be."

Mr. Alcan Hirsh, a graduate student in electro-chemistry at the University of Wisconsin, has succeeded in producing about half a pound of metallic cerium, one of the rare elements which heretofore has been isolated only in small quantities.

Sir Ernest Shackleton hopes in the course of next year to undertake an expedition to Spitzbergen, spending two and a half or three months in the islands. His party will probably consist of six, including Mr. J. Murray, the biologist, and other members of the *Nimrod* expedition.

Hon. Charles H. Sherrill, United States Minister to Argentine Republic, will give an address on February 16 to the officers and students of Columbia University on the opportunities for American engineers in public works and other fields in Argentine.

Dr. H. W. Wiley, chief of the division of chemistry of the Department of Agriculture

lectured before the Chemical Society of Washington and Lee University on January 13, his subject being "Some of the less Obvious Advantages of Chemical Study." Dr. J. W. Mallet, of the University of Virginia, is to lecture before the society on February 17.

PROFESSOR GEORGE T. MOORE recently gave a series of lectures before the Washington University Association on "What goes on in the Ground."

WITH a greatly increased equipment the new laboratory of St. Luke's Hospital, New York, has recently been opened. Some changes have been made also in the personnel of the laboratory staff, which now includes Dr. Francis C. Wood, director, Dr. Karl M. Vogel, clinical pathologist, Dr. J. Gardner Hopkins, bacteriologist, Dr. William H. Woglom, pathologist, Dr. George C. Freeborn, assistant in pathology, and Dr. N. B. Foster and Dr. H. O. Mosenthal, assistants in chemistry.

THE New York Zoological Park has received from Mr. E. B. Bronson, from Quito, Ecuador, a fine specimen of the Spectacled Bear (*Ursus ornatus*), captured in the Andes of Ecuador. Excepting the Æluropus, of eastern Tibet, this is the rarest bear species either alive in zoological gardens or in museums. The specimen is temporarily exhibited in one of the large cages of the small mammal house, where it will remain until the new series of bear dens now under contract and in the course of erection is completed, which will be about June first.

TWENTY-THREE cases of zoological material representing several hundred skins of birds and mammals have been received by the American Museum of Natural History as the first shipment of specimens from the Stefánsson-Anderson Arctic Expedition.

AT the last meeting of the Oregon Academy of Sciences a number of new members were elected. The subject of the evening was "The Single Tax," by C. H. Chapman, one of the editors of the *Oregonian*. The meeting was held early in the evening preceded by a dinner which was attended by about sixty-five persons. It was decided to use this plan for a part of the monthly meetings this year combining social and scientific features.

A GERMAN edition of "Light Waves and their Uses," by Professor Albert A. Michelson, head of the department of physics of the University of Chicago, has just been issued by the publishing house of Johann Ambrosius Barth in Leipzig. The translation was made by Dr. Max Ikle. The lectures which constitute the book were originally delivered by Professor Michelson in the Lowell Institute in 1899. The translator has added a bibliography of writings bearing on this subject published since 1880.

WE learn from *Nature* that the Agenda Club, which was formally inaugurated by a banquet recently, proposes to organize effort, knowledge and influence for the purpose of getting things done which need doing for the benefit of the community. The movement first acquired publicity through "An Open Letter to English Gentlemen" in the *Hibbert Journal*. This letter, and the club itself, appeal frankly to the idealism and the goodwill of the best men, but an equally essential characteristic of the club is to organize the altruism of its members with at least as much efficiency as that of the most successful modern business. The club expressly enunciates its need of guidance by scientific men in determining the agenda to be undertaken and in many details of its work. It is a coordinating society, and not one that overlaps the work of other bodies devoted to special purposes. Among other methods to be employed is that of the most extensive publicity. It contemplates the encouragement of research, especially in social science, and its scheme includes groups of associates, among which are mentioned engineering, literature, medicine and science.

THE Berlin correspondent of the *Journal* of the American Medical Association writes that on October 26 the Berliner medizinische Gesellschaft celebrated its semi-centennial. The memorial meeting was of peculiar importance, as this society is not only the largest medical association in Berlin, but also one of

the most noted and largest in Germany and can look back on a notable past. The society was formed by the union of two Berlin societies The older of these was founded in 1844 as a society for scientific medicine and the younger was the Verein Berliner Aerzte, founded in 1858 In order to obviate any difficulties arising from the union of the two societies, which took place in 1860, Rudolf Virchow resigned his position as president of the society for scientific medicine, in favor of Albrecht v Grafe, the president of the other society The Berlin Medical Society, in spite of the separation from it of numerous special associations, of which that founded by v Leyden as the Verein fur innere Medizin was the first, has still remained the central point of scientific medical activity in Berlin, and almost every Berlin physician considers it his duty to belong to it, so that at present it has more than 1,600 members. As a result of the participation of the university teachers, the scientific proceedings are always valuable and a number of important discoveries have been presented here for the first time As successors of v. Grafe, Bernhardt von Langenbeck, Rudolf Virchow, Ernst v Bergmann, and finally H. Senator have held the office of president. Robert Koch, Helmholtz and Pasteur were made honorary members, a distinction which has seldom been bestowed. On the occasion of the semi-centennial the number of honorary members was considerably increased, including in addition to two living members of the society, two physicians practising in Berlin, Professor Waldeyer and the surgeon general of the Prussian army, v. Schjerning, Naunyn (Baden-Baden), Exner and Fuchs (Vienna), Golgi, Armauer-Hansen (Christiania), Abraham Jacobi (New York), Fr Koranyi (Budapest), Keen (Philadelphia), Kitasato (Tokio), Laveran (Paris), Lépine (Lyons), Lister, Murri (Bologna), Pawlow (St. Petersburg), Ramon y Cajal (Madrid), Retzius (Stockholm), Salomonsen (Copenhagen) and Röntgen (Munich) Senator was elected honorary president. On the festival day it was announced that so far $15,000 (63,000 Marks) had been subscribed by the members for the building of the projected Virchow House, which is to be the special home of the society. The widow of Virchow on the same occasion announced that she would make over to the new building the private collections and valuable memorials of Virchow

AT a meeting of the trustees of the Beit memorial fellowships for medical research, the reports by the fellows on their work during the past year, which had been considered by the advisory board, were approved The following is a list of those who were elected to fellowships, the subject of research and the institution in which it is to be carried forward

Thomas Renton Elliott, M D (Cantab), M R C P (Lond) The pathological changes in the suprarenal glands Medical School of University College Hospital

Eric Edwin Atkin, M B (Cantab) A group of toxins with respect to the manner of destruction, mode of neutralization by antibody, and effect of the various modifications upon the animal organism The Bacteriological Laboratory of the London Hospital

Frances Mary Tozer, B Sc (Lond) The presence of sensory fibers in the third, fourth and sixth cranial nerves, their influence upon ocular paralysis in locomotor ataxia and other diseases, and the site of the ganglion cells The Physiological Laboratory of the Liverpool University

Richard Williams Harold Row, B Sc (Lond) The structure, development and functions of the pituitary body in vertebrata King's College, London, the Marine Biological Association's Laboratory, and the Naples Zoological Station

Henry Priestley, M B , Ch M (Sydney) The diphtheroid organisms with regard to their distribution, morphology, cultural characteristics, pathology and relationship to diseased conditions of man and animals The Lister Institute of Preventive Medicine

Frederick Perera Wilson, M D , M Sc (Liverpool) The changes in the lipoids of the tissues produced by syphilis and their relation to hæmolysis and immunity The Biochemical Department of the University of Liverpool.

Arthur Gurney Yates, M D (Edin) The bacteriology of acute rheumatism. The Pathological Department of the University of Sheffield

Annie Homer, D Sc., T.C.D The chemistry and

physiology of tryptophane, the metabolism and chemistry of hæmoglobin in so far as they bear on its production in the animal body, the comparison of normal and pathological tissues as regards their content of intracellular ferments The Physiological and Chemical Laboratories, Cambridge

Frederick James Fitzmaurice Barrington, M B, B S (Lond), F R C S The functions of the male accessory genital glands University College Medical School

John Foster Gaskell, M B, B C (Cantab), M R C P (Lond) The origin of the suprarenal body in the invertebrates and lower vertebrates and the function of chlorogogen cells in invertebrates St Bartholomew's Hospital Medical School

UNIVERSITY AND EDUCATIONAL NEWS

Harvard University has received an additional gift of $100,000 from Mr Adolphus Busch, of St Louis, Mo, towards the erection and maintenance of the Germanic Museum This sum makes a total of $350,000 given to the museum by Mr Busch

It is stated in the *Yale Alumni Weekly* that owing to the lack of room, notwithstanding the great wealth of material, the work of mounting prehistoric animals for public exhibition at Peabody Museum has been temporarily discontinued The development of the resources of the museum must apparently await new building construction This may involve an entirely new site and plant in accordance with the university development on the Hillhouse property The building fund of the institution, according to the last report of the university treasurer, amounted to $173,923

The Harvard University Catalogue shows this year a total enrollment of 4,123 students in the university exclusive of the summer schools, Radcliffe College, and the university extension courses. The total number of students is 77 more than it was at the corresponding period last year. The attendance in the college is 48 less than it was last year, but this decrease is more than offset by gains in the graduate and law schools.

Mr. Clarence T. Johnston has been appointed professor of civil engineering at the University of Michigan, succeeding Professor Emeritus J B Davis, retired on the Carnegie grant Professor Johnson was graduated from the University of Michigan as an engineer in 1895, and received the degree of C E in 1899 He was state engineer of Wyoming during the period in which were formulated the irrigation laws.

At a meeting of the trustees of Princeton University on January 12, 1911, William Gillespie, assistant professor, and George David Birkhoff, preceptor, were made full professors of mathematics Ulric Dahlgren, assistant professor of biology, was made full professor

DISCUSSION AND CORRESPONDENCE

CARELESS CRITICISM

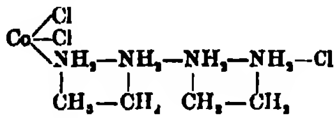
Within the past year a new book has appeared, bearing the title "Recent Advances in Physical and Inorganic Chemistry," by A W Stewart The book has received very favorable comment from the reviewers in various chemical journals, and deservedly so, for the author has selected certain striking lines of advance and has pointed out the chief experimental evidence on which these are based.

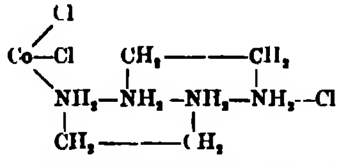
There is one glaring error, however, which seems to have escaped the notice of the reviewers In all of the chapters, except one, the author writes from the standpoint of the record as shown in chemical literature, but in this, the seventh chapter, The Cobaltammines, he departs from his usual conservatism and assumes the rôle of a caustic critic

After a discussion of the various views put forward to explain the structure of these compounds, the author plunges into the Jorgensen-Werner controversy, defending very earnestly Jorgensen's views and criticizing with equal warmth those of Werner. On page 121, following a discussion of the points at issue between Jorgensen and Werner, the author states:

Now, since all these difficulties arise only from the assumption that the ethylene diamine series of compounds are exactly parallel to the tetrammino-compounds, the simplest way out of the difficulty seems to be to abandon any such parallelism. Jörgensen pointed out that in the case of

ethylene diamine, we can imagine two possible arrangements with the cobaltammine molecule—





so that we might attribute the isomerism in these compounds to this difference Now, in the ammonia compounds such an isomerism could not occur, owing to the similarity of all four ammonia groups We should therefore expect to find no isomerism in the case of the ammonia-compounds of the type $[(NH_3)_4CoCl_2]$, *and, as a matter of fact, no such isomers are known, the compound exists in one form only*

And again on page 125, in summarizing the whole controversy, the author states

The question at issue is quite clear Jörgensen points out that if we take the three cases of the dichloro diethylene diammino salts, the dinitrito-tetrammino salts and the dichloro-tetrammino salts, two isomeric series are known in the case of the first two sets, but the dichloro-tetrammino compounds occur in one form only—

$\left[Co{Cl_2 \atop en_2}\right]X$	Occur in two forms
$\left[Co{(NO_2)_2 \atop (NH_3)_4}\right]X$	Occur in two forms
$\left[Co{Cl_2 \atop (NH_3)_4}\right]X$	Only one form known

So that in each case where isomerism is observed there are either two nitro groups or two ethylene diamine molecules Where these are both absent, no isomerism occurs. Werner, on the other hand, maintains that his theory accounts better for the facts, *though he has not been able to produce the two isomeric tetrammino salts which, according to his views, ought to exist* The non production of these salts is specially significant when we consider how easily we can transform one diethylene diamine isomer into the other; evaporation with mineral acids produces one form, from which the other can be regenerated by evaporating with water after making the solution neutral

Briefly, Dr. Stewart contends that Werner's views are untenable as he has not been able to prepare the isomeric modification of dichloro-tetrammino cobaltic chloride This is the crowning argument with which the chapter is closed

Unfortunately for the argument, Werner published in 1907 in so accessible a journal as the *Berichte der Deutschen Chemischen Gesellschaft*, Vol 40, p 4817, a full account of the discovery, the method of preparation, and the properties of this second and isomeric modification of dichloro-tetrammino-cobaltic chloride This was no accidental discovery, nor the result of haphazard experiment, but a logical consequence of the extension of Werner's views to the complicated poly-nucleal compounds, a field brilliantly developed by Werner during the past twelve years, but not mentioned in the chapter on Cobaltammines

The critic can not afford to be careless in keeping up with the literature of a subject The plea of recent publication of Werner's work on this compound can not be put forward, as Dr Stewart has included in this chapter the still later (1908) published views of Ramsay and of Friend, indeed, the date of his preface, September, 1909, shows that the manuscript was in hand two years after Werner's announcement in the *Berichte* of his success in preparing the isomeric modification of dichloro-tetrammino-cobaltic chloride.

CHAS H HERTY

UNIVERSITY OF NORTH CAROLINA,
CHAPEL HILL, N C,
December 16, 1910

SCIENTIFIC BOOKS

The Differentiation and Specificity of Corresponding Proteins and Other Vital Substances in Relation to Biological Classification and Organic Evolution The Crystallography of Hemoglobins By E. T REICHERT and A. P BROWN Washington, D C, published by the Carnegie Institution of Washington. 1909.

This is an important and very interesting work, the combined production of a physiologist and a crystallographer This review will be restricted to a consideration of some

of the results that are of interest to the biologist[1]

Hemoglobin, the coloring matter of the blood, which in vertebrates is contained in the blood corpuscles, and which is a combination of a proteid, the globin, with the coloring matter proper, the hematin, can more or less readily be obtained in the form of crystals Many investigators have studied the conditions under which these crystals form and some of their characters in different species of animals The work of Reichert and Brown is, however, by far the most thorough and extensive investigation which has so far been published, and on the basis of their careful studies the authors arrive at broad biological conclusions, which will be of great interest to a wide circle of scientists

The results obtained leave no doubt that the crystals of the hemoglobin of different species are not identical, and the work, moreover, raises problems which have not been considered by previous investigators The authors show that not only do the crystals of different species of animals differ, but also that this difference is a graded one, corresponding to the position which the various species occupy in the zoological system As the crystals of nearly related species resemble each other more closely than those of more distantly related species, the character of the crystals permits us to decide, within certain limits, how nearly related to each other animals are Furthermore, inasmuch as crystallographic characters are the expression of chemical constitution, we may conclude that the hemoglobin of various species shows gradations in its chemical constitution corresponding to the close or more distant relationship of the species. We may also assume that gradations parallel to those shown by the crystals of hemoglobin exist in the other proteins Thus we have a means of testing by crystallography the classification of animals, which at present is based almost entirely on morphological characters

The comparative study of the crystals of hemoglobin by the authors confirms, on the whole, the correctness of the classification generally adopted by zoologists, but there are certain instances in which the authors believe that their findings suggest a revision To cite two examples (1) It is ordinarily assumed that the white rat is an albino of the black rat, the crystallographic examination of the various species of rats shows, however, that the white rat is closely related to the brown or Norway rat, while the black, or Alexandrine rats are more nearly related to each other (2) The crystals of hemoglobin from the brown bat show a considerable resemblance to the crystals of hemoglobin of Papio, which belongs to the primates This agrees with the view of some zoologists, according to which the bats are related to the primates, although, on the other hand, the crystals of the fruit bat do not show this resemblance to those of Papio

On the whole, the main results of Reichert and Brown harmonize very well with our general biological conceptions of the graded relationship of differences in the chemical constitution of proteid substances, a conception mainly founded upon the results obtained through the application of the so-called biological tests (precipitin, anaphylaxis, complement fixation reactions), and especially are the conclusions of these authors in good agreement with the results of experiments in which watery extracts of erythrocytes have been used as an antigen and in which the erythroprecipitins obtained were shown to be specific for the antigens of the various species which had been employed These studies have definitely proved that the proteid substances from

[1] The reviewer consulted two experts in crystallography in regard to the soundness of the crystallographic basis of the work, and he may be permitted to cite here a few sentences

Professor Edward H Kraus, of the University of Michigan, states "From the crystallographic standpoint, Professor A P Brown has done a remarkable piece of work which is deserving of highest credit"

Dr J E Pogue, of the Smithsonian Institution "The actual crystallographic and optical details are apparently determined with skill and accuracy The photomicrographs are excellent, and the line drawings good"

the various organs of a certain species have in common a "species" group that is characteristic for one species and differentiates it from nearly related species. By these "biological" methods it had also been found that the constitution of these groups of proteid is more similar in nearly related than in more distantly related species, and several investigators, especially Osborne and Abderhalden, had previously taken up the problem of the chemical characterization of species differences by the methods of analytical chemistry.

The work of Reichert and Brown differs, however, in some important aspects from the previous investigations (differentiation by biological tests). While in the latter the substances compared with each other were usually chemically not well defined, Reichert and Brown worked with a definite chemical substance, the hemoglobin. By the method of crystallization it is, moreover, possible to detect differences in chemical constitution which are at present not accessible to ordinary chemical analysis and in this way it is possible to differentiate between species so nearly related, that even by means of the so-called biological tests the differentiation is accomplished only with great difficulty.

After a study of Reichert and Brown's work little doubt is left in the mind of the reader in regard to the usually close relationship of the crystals of the species belonging to one genus or occasionally even of the great similarity of the crystals of two nearly related genera, it seems, however, not yet established that a *general* parallelism exists between the true relationship of the various orders and classes of animals and the character of their hemoglobin crystals.

It might furthermore be questioned in those cases in which a divergence seems to exist between the ordinary classification and the results of the crystallographic studies, whether the latter should be accepted unhesitatingly. It rather seems that in such cases of doubt a comparative study by the crystallographic, and by the so-called biological tests should be used to confirm the former. This would be especially desirable in view of the great lability of the hemoglobin molecule which the authors themselves repeatedly emphasize. We might, *e. g.*, question whether the different kinds of crystals of oxyhemoglobin found occasionally in the same blood might not be the result of certain secondary chemical changes in the hemoglobin molecule. In this connection it is of interest that in a recent publication Offringa states, that if the crystals of hemoglobin of the horse are prepared without the addition of any salt (Reichert and Brown made use of oxalates in their work), only one kind of crystals is obtained.

In the work of Reichert and Brown, as well as in the more recent literature generally, the term "specific" is frequently encountered, and it is apparently supposed to have a definite biochemical meaning. A more searching analysis, however, reveals the fact that this term includes three different relationships between substances, and a clear distinction between these appears to be very desirable. Several years ago the reviewer described a class of substances which he designated as specifically adapted, these are substances coexisting in the same organism and showing functional relations to each other. In other cases the term "specific" merely indicates a character of a certain species by which it differs from other species, without any parallelism existing between this characteristic and the zoological classification. In a third class of specific characters such a relationship exists, and this third kind of specificity might appropriately be called "generic specificity." With the latter, we have principally to deal in the work of Reichert and Brown.

The work of these authors includes also a consideration of the general characters of hemoglobins as well as a summary of other differences which have been found in the blood of different species by previous investigators. With some opinions expressed in this part of the book issue might, perhaps, be taken, as for instance, in regard to the low estimate of the physiological importance of iron as a constituent of hemoglobin; a view

against which especially the recent investigations of W. Manchot might be cited.

The fine reproduction of 100 plates of beautiful microphotographs of hemoglobin crystals of various species of animals is especially noteworthy.

LEO LOEB

A Monograph of the Culicidæ or Mosquitoes. Volume 5. By FRED. V. THEOBALD. British Museum (Natural History). London. 1910. Pp. xvi + 646. 261 text figures, 6 plates.

The author has assembled in this volume descriptions of many recently erected genera and species, characterized thirteen genera and eighty species as new, supplied keys for the separation of the genera and a very large proportion of the described species and, in addition, gives observations or references to practically all other genera and species. This latter makes the fifth volume practically a systematic index to the preceding four volumes and will greatly facilitate future studies in this group.

The modified classification proposed by Lutz and outlined in volume four has been closely followed. We regret to note that the tables for the recognition of the genera are based largely upon scale structure, a method of separation which has found comparatively slight favor in America, though we can not ignore the author's statement, especially in view of his wide experience with these insects from all parts of the world, that separation in this manner is comparatively easy, as evidenced by the number of correctly named collections received at the British Museum. The monograph, as a whole, is weak from a structural and biological standpoint, and necessarily so in many instances, especially in the case of forms received from distant countries where methods of collection and preservation are far from ideal. The study of the imago must, as a rule, precede biological investigations, and it is therefore not surprising that the immature stages have received comparatively little attention in this work. We sympathize strongly with the author in his declining to recognize genera and species based solely upon larval characters, despite the fact that such procedure is not sanctioned by the International Code of Zoological Nomenclature. It is true that good characters are found in the larvæ of this group, and that in some instances species are more readily separated in the larval than in the adult form. Nevertheless, our classification of the family is based upon the imago, and confusion is bound to result from the employment of a double standard, though technically allowable, it is in this group questionable procedure.

There are important problems in synonymy which should be settled in the near future for the purpose of avoiding confusion if for no other reason. The author declines to accept the broad delimitation of Aedes, recently proposed in this country, and, as a consequence, the nomenclature used by a number of American workers differs widely from that employed in the volume under consideration. Personally, without having made special study of the problems involved, we question the wisdom of attempting to unite under one name such diversified forms. On the other hand, a number of generic names have been allowed to stand as valid in this work which will probably fall as synonyms because of the absence of satisfactory characters. These and similar questions can be settled only by an exhaustive comparative study of the characters presented by the immature stages as well as those of the adult. The key to the solution of many of these problems will be found in the unrivaled collections from all parts of the world, now assembled in the British Museum of Natural History.

The diversity and size of this group is indicated by the eight subfamilies recognized (excluding the Corethridæ), comprising some 146 genera and 899 species, a large majority of these being valid. The world owes Professor Theobald a debt of gratitude for assembling, carefully describing and arranging this immense amount of material, among which are included some of the most dangerous insect enemies of man. Prior to this study, our knowledge of the Culicidæ was

little better than chaotic, many species being unknown or else grouped under a specific name mostly noteworthy because of its comprehensiveness We think all will agree that Professor Theobald has done a large amount of valuable pioneer work, though we may not adopt all of his taxonomic views The British Museum is to be congratulated upon having published such an admirable work, of which the volume under consideration forms only a part, consisting of five good-sized volumes, illustrated by a large series of figures, there being over 1,200 text illustrations and 88 magnificent plates, and characterizing practically all the known species in this important family It is perhaps needless to add that this monograph on the Culicidæ, possibly not even yet completed, must be the major foundation for all subsequent studies in this group and therefore nearly indispensable to the systematist

E P FELT

SPECIAL ARTICLES

NEW PHENOMENA OF ELECTRICAL DISCHARGE

AT a meeting of the Academy of Science of St Louis on December 5, the writer gave further results of work on electrical discharge It had been previously shown that oscillations of widely varying frequency, attended by musical tones, could be brought about, by means of small spark gaps of variable length, in the lines leading from the terminals of an influence machine to the main gap across which the discharge is to pass In a former paper it had been suggested that the striæ in a vacuum tube were in the nature of waves in an organ pipe

These results suggested the idea of imposing resonance vibrations in a column of air contained in a glass tube, which also contained terminals from the influence machine. The air vibrations were produced by means of a blast of air from a pressure tank, which was directed across the mouth of another tube. It has been found that with very careful adjustments, the electric discharge across a small gap in the glass tube could be affected in a marked way by the impressed sound waves A luminous discharge was apparently converted into a dark discharge

The line within the tube containing this gap was in multiple with another line containing an adjustable gap This system was in the positive side of a circuit which contained a long discharge gap Placed transversely in this gap was an insulated sheet of copper, which served to prevent disruptive discharges Attempts are now being made to cause an organ pipe to sound a musical tone by means of periodically varying electrical stresses within the air-column The response of the air-column is not as marked as when the vibrations are produced in the ordinary way Some effects have however been secured, and there is every reason to believe that the attempt will meet with success These results can only be considered as preliminary

Several friends have suggested that the term drainage column as applied to the positive or luminous end of a discharge, was another name for an ionized mass of air If we say that air is ionized by X-rays passing through it, this term does not represent the conditions at either terminal of an influence machine

In a mass of air ionized by X-rays, the average charge of a molecule is the normal charge Those which have a greater than normal charge mingle with those which have a less than normal charge Such a mass of air will respond to the demands of an electrometer placed within it, whether its leaves have a greater or a less than normal charge The supercharged molecules will deliver the excess to those whom they have robbed, or to any others which may be in a like condition A similar statement may be made concerning the molecules which have less than the normal charge. But such a mass of air is not a drainage column It is in a condition which promotes the formation of a drainage column, if the terminals of some "source" of electricity like an influence machine are placed within the ionized mass of air This mass of air is then made a part of the conducting circuit, by the starting of the machine into action The fact that it behaves differently from the rest of the circuit is incidental to the fact

that it is in gaseous condition. The apparent discharge into the air from the positive terminal was shown by phenomena described in my paper of February 18, 1910,[1] to be an inflow of negative electricity to that terminal. The electric fluid is thus drained from a column of air which begins at the positive terminal and extends towards the negative or compression terminal. After this drainage has been brought about, the air within this column is in a very different condition from that of air ionized by X-rays. The average charge per molecule of air is then less than the normal amount. By placing an insulated sheet of copper between the terminals, the drainage or conduction column is prevented from reaching the mass of supercharged air in front of the negative terminal. Loud disruptive discharges will pass when the plate is removed, and they cease at once when the plate is placed midway between the terminals. On moving the copper plate nearly to the negative glow, the drainage column follows it, and a torrent of sparks will pass.

The so-called positive ions do not emerge from the wire at the positive terminal, and they do not enter the wire at the negative terminal. When this air is nearly all removed from the discharge gap, as is done in the Crookes tube, the cathode discharge still continues. The drainage column has disappeared at the anode. When the air is partially removed, thus increasing the mean free path, the drainage column may have a great length, and it follows all of the windings and bends of the tube. It would not do this if it were an outward discharge like that from the negative terminal.

This drainage column constitutes the canal rays, in a tube where the gas has been partly exhausted, so that the mean free path has been increased. In a paper to be published by the Academy of Science of St. Louis, phenomena of canal rays in air of ordinary pressure will be presented, in connection with phenomena involved in vibrations imposed upon the air column.

[1] *Trans. Acad. of Sc. of St. Louis*, Vol. XIX, No. 1, Plates II to VIII.

If any trace of a positive fluid capable of moving through a wire as an electric current must move could be found, and if the two-fluid theory could furnish an adequate and rational explanation of these and other phenomena, there would be no objection to its use in an exposition of the subject, as has been the custom heretofore.

In 1895 the writer showed that the velocity of flow of the electric fluid in a pumping service then discussed, must be very great. Imagine two spheres having radii equal to that of the earth. Suppose electricity to be pumped from one into the other, until their difference in potential is 50 volts. Connect them by means of a 50-volt one-ampere lamp. It would begin to glow with normal brightness. In order to keep the voltage constant the radii of the two spheres must be diminished with a uniform velocity of more than half the velocity of light. This store of electricity would maintain this lamp at normal candle power for 0.035 second. The operation must be repeated 28 times a second. The time for one stroke of the piston is in seconds, $t = Rr$, where r is the radius of the spheres in cm. and R is the resistance of the lamp in electrostatic units. If the sphere from which the electric fluid were pumped, by some adequate means, had an infinite capacity, the other sphere must then be charged to a potential of 50 volts, and the above results would remain unchanged. The surface of the charged sphere would then be the piston of an electrical pump, and its velocity would be as given above. All of this store of electricity must pass through the lamp in 0.035 second.

We may learn much about the constitution of matter by a study of what are called the positive ions when an electric discharge is passed through a column of gas. But nothing has yet been learned to indicate that these ions play any part in a lamp circuit, except that they then constitute the solid conductor.

Wheatstone's work now shows us that when half a mile of copper wire is placed centrally in the spark gap, we have compression and rarefaction waves in Franklin's fluid, which meet at or near the middle of the wire. The

positive ions are in some way linked together, and transmit Thomson's corpuscles with immense velocity. There is a certain amount of shaking up involved in this transfer. It is the Joule effect. The positive ions remain at rest, and there are, therefore, no canal rays. When this wire is removed from the spark gap, the gas molecules receive the same compression and rarefaction waves, if the man who turns the crank of the machine continues his work. At the negative terminal the air molecules are loaded with the corpuscles, in the region of negative glow. They are then urged by convection as carriers, across the Faraday dark space. At the positive terminal the corpuscles pass from the gas into the metal conductor by a rarefaction or drainage process. Photographic plates reproduced in former papers[2] show that the drainage lines begin at the positive terminal. In this drainage column the carriers of the discharge move in a direction opposite to that in which the discharge is being urged. Cakes of ice floating on water would behave in a similar way, if a runner should jump from one to another, although the mechanism would be different. Nevertheless, such behavior of cakes of ice appears to be related to the athletics of the foot race, in somewhat the same way that positive ions in a gas are related to the flow of electricity in a power circuit.

FRANCIS E. NIPHER

JOINT MEETING OF MATHEMATICIANS AND ENGINEERS AT MINNEAPOLIS

THREE years ago in connection with the convocation of the American Association for the Advancement of Science in Chicago, a joint meeting of mathematicians and engineers was arranged through a committee of the Chicago Section of the American Mathematical Society. This meeting aroused much interest and resulted in the appointment of a committee of twenty, under the chairmanship of Professor E. V. Huntington, of Harvard University, to consider the whole question of the teaching of mathematics to students of engineering in this country, and to report its recommendations to the Society for the Promotion of Engineering Education at its summer meeting to be held at Madison, Wis., in June, 1910. This committee was constituted as follows: Philip R. Alger, professor of mathematics, U. S. Navy, Annapolis, Md.; Donald F. Campbell, professor of mathematics, Armour Institute of Technology, Chicago, Ill.; Edmund A. Engler, president of the Worcester Polytechnic Institute, Worcester, Mass.; Charles N. Haskins, assistant professor of mathematics, Dartmouth College, Hanover, N. H.; Charles S. Howe, president, Case School of Applied Science Cleveland, Ohio; Emil Kuichling, consulting civil engineer, New York City; William T. Magruder, professor of mechanical engineering, Ohio State University, Columbus, Ohio; Ralph Modjeski, civil engineer, Chicago, Ill.; William F. Osgood, professor of mathematics, Harvard University, Cambridge, Mass.; Charles S. Slichter, consulting engineer of the U. S. Reclamation Service, professor of applied mathematics, University of Wisconsin, Madison, Wis.; Charles P. Steinmetz, consulting engineer of the General Electric Company, professor of electrical engineering, Union University, Schenectady, N. Y.; George F. Swain, consulting engineer, professor of civil engineering, Harvard University, Cambridge, Mass.; Edgar J. Townsend, dean of the College of Science and professor of mathematics, University of Illinois, Urbana, Ill.; Frederick E. Turneaure, dean of the College of Mechanics and Engineering, University of Wisconsin, Madison, Wis.; Clarence A. Waldo, head professor of mathematics, Washington University, St. Louis, Mo.; Gardner S. Williams, consulting engineer, professor of civil, hydraulic and sanitary engineering, University of Michigan, Ann Arbor, Mich.; Calvin M. Woodward, dean of the School of Engineering and Architecture and professor of mathematics and applied mechanics, Washington University, St. Louis, Mo.; Robert S. Woodward, president of the Carnegie Institution of Washington, Washington, D. C.; Alexander Ziwet, professor of mathematics, University of Michigan, Ann Arbor, Mich.

In the early part of its investigation the committee collected a large amount of information in regard to the present status of mathematical instruction for engineering students. Since that time, however, a much more inclusive inquiry has been undertaken by the International Commission on the Teaching of Mathematics, of which the American Commissioners are Professors D. E. Smith, J. W. A. Young and W. F. Osgood. In

[2] *Trans. Acad. of Sc. of St. Louis*, XIX., Nos. 1 and 4, Plates X., B, XX., A, B and C, and XXI., A.

order to avoid unnecessary duplication, this committee voted to turn over all the results of its own inquiry in this field to the larger commission, to be worked up in accordance with the general scheme adopted by that commission, and to be incorporated in their report This material is therefore not included in the present report

Aside from the collection of data, Professor Huntington's committee decided that the most important need at the present time is a series of synoptical text books, which shall present (1) the fundamental principles of the science, in compact form, and (2) a classified and graded collection of problems (which would naturally be subject to continual change and expansion). It is their hope that the Minneapolis report, which is confined to the first part of the desired text-book, will stimulate throughout the country practical contributions toward the second

Copies of these syllabi were distributed among the hundred or more engineers, physicists and mathematicians who joined in a good fellowship dinner on the evening preceding the presentation of the report Additional copies may be had upon request from the chairman The following quotations from the preface will indicate its scope and purpose

"The object of this report is to present a synopsis of those fundamental principles and methods of mathematics which, in the opinion of the committee, should constitute the minimum mathematical equipment of the student of engineering

"It is hoped that this report may be serviceable in two ways first, to the teacher, as an indication of where the emphasis should be laid, and secondly, to the student, as a syllabus of facts and methods which are to be his working tools It does not include data for which the student would properly refer to an engineer's hand book, it includes rather just those things for which he ought never to be obliged to refer to any book—the things which he should have constantly at his fingers' ends

"The teacher of mathematics should see to it that at least these facts are perfectly familiar to all his students, so that the professor of engineering may presuppose, with confidence, at least this much mathematical knowledge on the part of his students On the other hand, if the professor of engineering needs to use, at any point, more advanced mathematical methods than those here mentioned, he should be careful to explain them to his class

"The defects in the mathematical training of the student of engineering appear to be largely in knowledge and grasp of fundamental principles, and the constant effort of the teacher should be to ground the student thoroughly in these fundamentals, which are too often lost sight of in a mass of details

"The committee has not found it possible to propose a detailed course of study The order in which those topics should be taken up must be left largely to the discretion of the individual teacher The committee is firmly of the opinion, however, that whatever order is adopted, the principal part of the course should be problems worked by the students, and that all these problems should be solved on the basis of a small number of fundamental principles and methods, such as are here suggested"

The report was freely discussed and frankly criticized by a large number of speakers including the following Professors E J Wilczynski, University of Chicago, A G Hall, University of Michigan; E H Comstock, School of Mines of the University of Minnesota, G A Miller, University of Illinois, A. E Haynes, College of Engineering of the University of Minnesota, E F Nichols, president of Dartmouth College, T F Holgate, dean of Northwestern University, Alexander Ziwet, University of Michigan; E R Maurer, College of Engineering of the University of Wisconsin, Henry Crew, department of physics of Northwestern University, H E Slaught, University of Chicago, B L Newkirk, University of Minnesota, E. F Chandler, University of North Dakota, J J Flather, head of mechanical engineering, University of Minnesota, and L E Dickson, University of Chicago, chairman of the meeting Also numerous discussions in writing were received by the chairman or through the secretary, including one from President R. S Woodward, of the Carnegie Institution of Washington, one from Professor A E Haynes, of the University of Minnesota, and one from William Kent, president of the Technical Literature Company of New York

The discussion finally led to the following resolution, which was unanimously adopted·

Resolved, that this body tenders hearty thanks to Professor Huntington for the great interest which he has shown in this work and the untiring service which he has given to it, that we commend the work of the entire committee for the preparation of a report which it is believed must operate for betterment along the lines of its

recommendations, and while not prepared to approve in all respects the details, especially in the syllabus on dynamics, as shown by the full and free discussion at this meeting, yet we heartily endorse the spirit of the report and thank the officers of the Society for the Promotion of Engineering Education, who have shown their friendly cooperation in offering to publish these syllabi in their official *Bulletin*, for the purpose of drawing out further criticisms and suggestions either in printed papers or in written communications to the chairman of the committee

The further report of this committee is to be presented at the next meeting of the Society for the Promotion of Engineering Education in June, 1911 The present meeting was organized, as was the original meeting in Chicago in 1907, by the Chicago Section of the American Mathematical Society

Other papers read before the Chicago Section at the Minneapolis meetings, aside from those in astronomy for which joint sessions were held with Section A, were as follows

"On the Use of the Co-sets of a Group," Professor G A. Miller, University of Illinois

"Congruencial Theory of Functions of Several Variables," Professor L E Dickson, University of Chicago

"Generalizations of Theorems on Linear Algebras," Professor L E Dickson

"On Primitive Roots of Ideals," Professor Jacob Westlund, Purdue University.

"The Problem of Defining the Set of Real Numbers," Dr A B Frizell University of Kansas

"A Historical Note on the Newton Raphson Method of Approximations," Professor Florian Cajori, Colorado College

"One Parameter Families and Nets of Plane Curves," Professor E J Wilczynski, University of Chicago

"Circular Numbers for a Plane Curve," Dr Horace T Burgess, University of Wisconsin

"Rational Anharmonic Curves upon a Quadric," Dr. Horace T Burgess

"The Applications of Matrices to Cubic Forms," Dr Horace T Burgess

"Envelopes of One Parameter Families of Plane Curves," Professor Walter J Risley, James Millikin University, and Professor W E MacDonald, Canton College, China

"A Reduction of Two Power Series in Many Variables to Two Equivalent Polynomials," Dr. W D MacMillan, University of Chicago.

"The Path of Light in a Medium Homogeneous in Concentric Spherical Layers," Dr Harris F MacNeish, Yale University

"The Curves of Equal Action for Elliptical Coordinates," Professor Kurt Laves, University of Chicago

"Robert of Chester's Translation of the Algebra of Al Khowarazmi," Professor L C. Karpinski, University of Michigan

"Hindu Numerals in the Kitab al Fihrist," Professor L C Karpinski.

"Ruled Surfaces and Planed Hypersurfaces in Four-Dimensional Space," Dr. Arthur Ranum, Cornell University

"Transformation Groups and Substitutions of an Infinite Degree," Dr L I. Neikirk, University of Illinois

"Use of Quaternions in Differential Geometry," Professor J B Shaw, University of Illinois

"On Plane Quintic Curves," Dr H L Slobin, University of Minnesota

"On the Construction of a Certain Class of Periodic Solutions of the Problem of Three Bodies," Professor F R Moulton, University of Chicago

"Curves on Quintic Scrolls," Professor Frank B Williams, Clark College

The next meeting of the Chicago Section will be in Chicago on Friday and Saturday, April 28 and 29, 1911

H E SLAUGHT,
Secretary of the Section

THE AMERICAN PHYTOPATHOLOGICAL SOCIETY

THE second annual meeting of the American Phytopathological Society was held in affiliation with the American Association for the Advancement of Science at Minneapolis, Minn, December 28–30, 1910. The attendance was not as large as at the Boston meeting, but an excellent program of twenty-eight papers was presented A joint session with Section G of the American Association and the Botanical Society of America was held at the Minnesota Agricultural College on Thursday, December 29, and other sessions at the University.

The society wishes to express its appreciation and gratitude to the local committee and especially to Dr. F. E Clements for the excellent rooms and facilities provided

The constitution of the society, drafted and approved by the council, was adopted The following officers were elected

President—Professor A D. Selby, Ohio Agricultural Experiment Station, Wooster, Ohio

Vice-president—Dr R. A Harper, University of Wisconsin, Madison, Wis

Secretary-treasurer—Dr C L Shear, U S. Department of Agriculture

Members of Council—Dr G P Clinton, Connecticut Agricultural Experiment Station, New Haven, Conn one year, Dr Erwin F. Smith, U S Department of Agriculture, two years The two *ex officio* members of the council are Dr F L Stevens, retiring president, and Dr L R. Jones, chairman of board of editors of *Phytopathology*

The following editorial board for the new journal *Phytopathology* was elected

Editors—L R Jones C L Shear, H H. Whetzel

Associate Editors—G P Clinton, E M Freeman, H T Gussow, F D Heald, Haven Metcalf, W A Orton, W M Scott, A D. Selby, Erwin F Smith, Ralph E Smith, F L Stevens and Roland Thaxter, with Donald Reddick as business manager.

The society elected thirty seven new members The next annual meeting will be held at Washington, D C, in affiliation with the American Association for the Advancement of Science.

The following committee on legislation concerning plant diseases was appointed: Mel T Cook, F L. Stevens, F C Stewart, H T. Gussow and A D Selby, *ex officio* The committee on names of plant diseases presented a report and was continued

The following papers were presented.

"Tannin in Relation to the Enzymes of the Plant Cell,' Mel T Cook

"The Persistence of *Bacillus amylovorus* in Pruned Apple Twigs," H. R. Fulton (Read by C L Shear)

"The Industrial Fellowship in Plant Pathology," H. H Whetzel.

"*Sclerotium rhizoides* Auersw. on *Calamagrostis*," A. B Stout

"The Relation of Temperature to Spore Germination and Infection with *Cystopus*," I. E. Melhus

"The Rusts of White and Red Clover," Frank D. Kern. (Read by title)

"Black Leg or *Phoma* Wilt of Cabbage, a New Trouble to the United States caused by *Phoma oleracea* Sacc," Thos. F Manns (Read by A. D. Selby)

"The *Fusarium* Blight and Rot of Potato; Field Experiments in Prevention," Thos. F. Manns (Read by A. D. Selby.)

"The White Pine Blister Rust," Perley Spaulding (Read by Haven Metcalf)

"A Study of some Anthracnoses and their Relations to a Sweet Pea Disease," J J Taubenhaus (Read by Mel T Cook)

"The Ascogenous Form of the Fungus causing Dead-arm of the Grape," C L Shear.

"Further Notes on the Bark Disease of the Chestnut," Haven Metcalf and J Franklin Collins

"Necrosis and Crown Gall Diseases of Grapes in New York," D Reddick.

"Peach Leaf curl in Nursery Stock," V B. Stewart (Read by D Reddick)

"Some Laboratory and Field Studies on Fungicidal Values," E Wallace, F M Blodgett and Lex R Hesler (Read by H H. Whetzel)

"Varietal Resistance of Beans to Anthracnose," M. F Barrus (Read by H H Whetzel)

"A Preliminary Report upon the Effects of Arsenical Compounds upon Apple Trees," B D. Swingle (Read by C. L Shear)

"Results of Cotton Anthracnose Work for 1910," H W. Barre.

"Notes on some Diseases of Trees in our National Forests, II," George Grant Hedgcock. (Read by title)

"A New Fruit Spot of Apple," W M. Scott. (Read by C L Shear)

"Contribution to our Knowledge of the Mine Fungi of the United States," C J. Humphrey

"A Bacterial Disease of Bananas and Plantains," James Birch Rorer. (Read by Erwin F. Smith)

"The Leaf Spot of Sugar Beets," C. O. Townsend (Read by title.)

"Notes on Hypertrophied Structures," Mel T. Cook

"The Grand Rapids Tomato Disease," Erwin F. Smith.

"Crown Gall of Plants," Erwin F. Smith.

"Cereal Smut Spore Germination," E. C. Stakman. (Read by title.)

"Alfalfa Rust and Timothy Rust in Iowa," L. H. Pammel.

Abstracts of these papers will appear in the April number of *Phytopathology*, the new journal of the society, and some of the papers will be published later in the same journal.

C. L SHEAR,
Secretary

SOCIETIES AND ACADEMIES

THE NEW YORK ACADEMY OF SCIENCES
SECTION OF BIOLOGY

A REGULAR meeting of the section of biology was held at the American Museum of Natural History, November 14, 1910. In the absence of Chairman Charles B. Davenport, Dr. Alexander Petrunkevitch presided. The following papers were read:

The Effects of Exposure on the Gill Filaments of Fishes: RAYMOND C. OSBURN.

Salmonoid fishes hatched and reared under artificial conditions frequently show a malformation of one or both of the gill covers, as a result of which the gill filaments are exposed. This condition has been observed in many hatcheries, the percentages sometimes being as high as twenty per cent. The deformity in the fishes studied is produced by the rolling in of the operculum. 486 yearling silver salmon reared in the New York Aquarium were examined with the following results: normal, 397; right opercle short, 44; left opercle short, 27; both opercles short, 18; percentage of abnormality, 18.31.

On examination under the microscope the exposed filaments are found to be quite abnormal. The epithelium, instead of being composed of thin flattened cells, is greatly thickened, consisting of cuboid or columnar cells, and in some cases several layers of the cells are found. The secondary laminæ, in which respiration for the most part takes place, are often reduced or wanting and the blood capillaries are not fully developed.

The hypertrophy of the epithelium, while it undoubtedly protects the filaments against abrasion, must at the same time seriously interfere with their function in respiration. The cause of the deformity of the opercle is unknown. Fish culturists have noted its appearance very early in fry, but whether it is congenital or is induced by crowding or by other untoward conditions in the hatching trays, further observations must decide.

Courtship in Tarantulas: ALEXANDER PETRUNKEVITCH.

The instincts of the male tarantula change suddenly at the period of maturity. From a creature with domestic habits he develops into a vagabond. Disregarding personal danger he constructs a sperm-web into which he throws out his sperm and pumps it then into both of his palpi. In the search for the female he is entirely dependent upon his sense of touch, his sense of sight being entirely inadequate for the purpose. The courtship is therefore very short and consists in beating the female with his front legs. The danger of being hit by the fangs of the excited female is prevented by catching them with the hooks on the front legs. The coitus lasts not longer than one half minute, after which the spiders cautiously separate. A few weeks later the males die apparently a natural death.

AT the regular meeting of this section held at the American Museum, December 12, 1910, Mr. Roy W. Miner presiding, the following papers were read:

The Effect of Changes in Water Density on the Blood of Fishes: G. G. SCOTT.

When salt water fishes are placed in fresh water they gain in weight. Investigation of the blood shows that there is a decrease in number of corpuscles per cubic millimeter and that the specific gravity of the blood decreases.

Tests with the Beckmann apparatus show that the freezing point of the blood of such fishes is higher than that of normal blood. If the fishes are placed in a solution of sea water plus sea salt, the corpuscle count is increased, the specific gravity of the blood is greater and the freezing point of the blood is depressed. A chemical examination of the chlorides of the blood of normal fish as compared with the chlorides of fishes kept in fresh water, shows that the loss of chlorides in case of the fishes experimented on is greater than the mere dilution of the blood by the endosmosis of water would account for. Hence, under the abnormal conditions to which the fish is subjected the gills become permeable to salts. The osmotic pressure of the blood is thus profoundly changed. That these changes reach the tissues is indicated by investigations now going on. The death of the fish which usually accompanies such sudden transitions as are employed in these experiments is possibly caused by conditions set up similar to those in such diseases as dropsy. It is hoped that further investigations now being carried on will clear up this question.

Marine Ecology and its Representation in a Museum: ROY W. MINER.

The speaker described the chief associations of marine animals to be found between the tides or just below the lower tide limits along the north Atlantic coast, with especial reference to the annulates and mollusca and the fauna of wharf piles in the Woods Hole region and the north shore of Long Island. The methods of collecting were then briefly outlined, and the chief steps for preserving data, observations, etc., for museum ecological groups were mentioned. The speaker then discussed the problems connected with con-

structing and installing groups and models of invertebrates in a museum. Colored slides were shown both of the living invertebrates and of their habitats, and also of the models and groups in course of construction and as completed at the American Museum The speaker concluded by exhibiting two sketch-models prepared under his direction by Messrs Mataush and Shimotori, of the museum staff, as preliminary studies for the annulate and pile fauna groups which are in course of construction in the American Museum.

Exhibition of Models of Membracidæ. IGNAZ MATAUSCH

The speaker exhibited a series of six enlarged models in wax which he had prepared for the American Museum of Natural History, as well as a series of twenty-three colored drawings and a collection of typical specimens which had been sent him by Professor F Silvestri, of Portici, Italy.

The Membracidæ, or tree-hoppers, are among the most interesting of insects Very little is yet known concerning their *life histories*, a subject to which the speaker said he had devoted considerable attention They are remarkable for their extraordinary variation in the form of the prothorax In order to make an enlarged model it is necessary to dismember the insect and to prepare drawings of the different parts to a selected scale The separate parts are then copied in clay, plaster molds are then prepared and casts made in wax These are then finished, the details put in, and the whole put together and colored

L. HUSSAKOF,
Secretary

AMERICAN MUSEUM OF NATURAL HISTORY

THE AMERICAN CHEMICAL SOCIETY

NEW YORK SECTION

THE fourth regular meeting of the session of 1910–11 was held at the Chemists' Club on January 6

The Nichols medal, awarded annually for the best paper read before the section, was presented to M A Rosanoff and C W Easley for their paper "On the Partial Vapor Pressures of Binary Mixtures" Professor W D Bancroft, president of the society, made the presentation and Professor Rosanoff accepted the medal on behalf of himself and Professor Easley

In receiving the medal, Professor Rosanoff said

"*Mr. Chairman, Dr. Bancroft, Dr. Nichols, Gentlemen*: I thank you all, on behalf of Dr. Easley and myself, for the great honor you are this evening bestowing upon us. It will be an ever present support against discouragement in the research struggle to which, I hope and believe, my life will be devoted to the end.

"Much of the honor adjudged to us is due—it is a pleasure to admit—to Clark University, whose unexampled freedom, and liberalism, and Nietzschean belief in the future, form an ideal atmosphere for scientific research.

"Gentlemen, Ostwald prophesies that the center of gravity of science is bound to move from Europe across the Atlantic This chemical society, a body devoted mainly to the furthering and encouragement of chemical research, can do more than any other group of men, more even than the universities, toward hastening that migration, which will open a remarkable era in American history. Every honor conferred by the society on the basis of research must stimulate that migration and will, therefore, rebound to the society itself"

Mr T. J Parker gave an account of the Minneapolis meeting of the American Chemical Society.

Dr W C Moore read a paper by Professor H N McCoy and himself on "Organic Amalgams"

Professor Robert Kennedy Duncan addressed the section "On the Relation between Chemistry and Industry in America" Formal discussion of the subject followed by M C Whitaker, L. H. Baekeland and Allen Rogers

C M JOYCE,
Secretary

THE BIOLOGICAL SOCIETY OF WASHINGTON

THE 476th regular and 31st annual meeting was held at the hall of the Cosmos Club, December 10, 1910, with President T S. Palmer in the chair

Reports of the secretary and treasurer were read and approved. Four new members were elected

The following officers for 1911 were elected

President—David White

Vice-presidents—W. P. Hay, E. W Nelson, J. N Rose and Edw. L. Greene

Recording Secretary—D. E. Lantz.

Corresponding Secretary—N. Hollister

Treasurer—J W Gidley

Members of the Council—A D Hopkins, A. K. Fisher, Vernon Bailey, A. B. Baker and Paul Bartsch.

D. E LANTZ,
Secretary

SCIENCE

Friday, February 3, 1911

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MSS. intended for publication and books, etc., intended for review should be sent to the Editor of Science, Garrison-on-Hudson, N. Y.

A UNIVERSAL LAW[1]

Now that we appreciate fully that physics, geology, engineering, physiology, medicine, botany, zoology and biology are sub-divisions of the broader science of chemistry, we see that the chemist of the future must know a great deal more than any of us now do if he is to keep in touch with the whole subject Many people believe that this is impossible and that the scientific man of the future will be a narrow specialist, knowing only a small part of a single division of one science I do not believe this As we look back over the history of any science, we see always two opposing tendencies—one that complicates and one that simplifies The discovery of new facts makes a subject more complex and more difficult to grasp The discovery of new relations simplifies matters because it enables us to correlate facts and thus to get a better grasp of the subject[2]

In the chemistry of to-day we have three great, simplifying generalizations which are familiar to all of you · the atomic theory, the periodic law and the phase rule. These have long since proved their value as a means of correlating facts and as working hypotheses enabling us to predict new facts The value of these is not great, however, when we get beyond what is called chemistry in the narrower sense of the word

As one universal law we have the great, simplifying generalization known as the

[1] Address of the retiring president of the American Chemical Society at Minneapolis, December 28, 1910.

[2] Cf Bancroft, *Proc. Elisha Mitchell Soc.*, 20, 39, 1904

law of the conservation of energy. The marvelous effect of this in enabling one to correlate and remember apparently unrelated facts was brought out in a most striking way in Kundt's lectures on physics

I wish to call your attention to-night to what I believe to be another universal law, a qualitative one and not a quantitative one The chemists call it the theorem of Le Chatelier The physicists call it the theorem of De Maupertuis or the principle of least action By the biologists it is known as the law of the survival of the fittest, while the business man speaks of the law of supply and demand. The broadest definition of it is that a system tends to change so as to minimize an external disturbance

In chemistry proper and in physics we study chiefly the effects of temperature, pressure, concentrations, electricity and light, but in the natural-history sciences we must also take account of moisture, food and fertilizers, secretions, climate, etc

If we heat a liquid we convert a portion of the liquid into vapor, an operation which absorbs heat If we heat a saturated solution, the solubility increases if the solid dissolves with an absorption of heat. If we increase the pressure on a dissociating compound or if we increase the concentration of the dissociation products, we get a decrease of dissociation which involves a decrease in pressure and a decrease in the amount of the dissociation product If we pass an electric current through a solution, we tend to get a counter-electromotive force which cuts down the electrical stress If we have suspended particles in a liquid, a difference of potential causes them to move in the direction which reduces the electrical stress. Since all substances absorb light of some wave-length to a greater or less extent, all substances are light-sensitive to some rays and tend to change in such a way as to eliminate the strain caused by the light. Whether any measurable change takes place depends on other conditions With some silver salts or with Eder's solution of mercuric oxalate, we get visible decomposition With chromium salts we get no measurable change unless some reducing agent is present With some substances we get fluorescence or phosphorescence, but ordinarily without apparent change With a copper sulphate solution there is apparently no effect due to light Yet all these solutions are really light-sensitive and they all tend to change in the same way, namely, to eliminate the substance which absorbs the light

In the business world continuous over-production of any commodity necessitates a fall in the price of the article. Also, a sufficiently wide-spread and prolonged decrease in the demand for meat will bring down the price, at least temporarily This may not help the consumer, because he may have to pay more for fish, eggs and vegetables, but that is not our problem

If one should ship enough copper abroad as export copper and should bring it back as ballast, one would create a state of strain which would eventually play havoc with the price of copper It is said that this experiment was tried when the price of copper was over twenty cents, but the details have never been published Over-production of silver destroyed the ratio of sixteen to one, while over-production of gold is now said to be one of the factors in the high cost of living

In physiology and medicine we find many illustrations of our law. "When irritating substances get into the eye, a flow of tears occurs to wash them away; from the nose and respiratory passages, they are ejected by sneezing or by cough;

and from the stomach or intestines they are removed by the vomiting and purging to which they themselves give rise[3]

If a splinter lodges in one's finger and is not removed, festering occurs and the splinter is sloughed out The throwing off of a cold is merely the elimination by the system of the disturbing factors and the same may be said about the recovery from any disease. Herter[4] says that "disease is generally the expression of a reaction on the part of the cell to injurious influences"

When studying chemical reactions, we find some cases, such as the inversion of sugar, in which the reaction products have little or no effect on the reaction In many other cases, the reaction may come to an end if the reaction products are not removed In these latter cases the reaction products might be said to be toxic to the system Analogous cases occur in physiology Some secretions or reaction products are not toxic to the system, while others are Brunton[5] says that "cells excrete poisons formed within their bodies [and that] an excessive quantity of their own products is usually injurious to cells" We all know that the waste products of digestion must be removed from the intestines periodically or poisoning will ensue, and we also know that the system tends to react in such a way as to remove these products

In the cases thus far considered, it has been fairly clear what the response of the system would be, but this is not always so. If a man goes out into the street and slaps another man's face, he creates a state of strain, which may be relieved by the other man's running away It is quite possible, however, that the other man may knock the first man down, or he may hand the first man over to a policeman, if one happens to be near What happens depends on the relative sizes and temperaments of the two men and on the nearness of the policeman We can not make A, B and C represent the first man, the other man and the policeman, and then interchange the letters We have the same thing in mixtures of three liquids If we add one liquid to another, we always lower the vapor pressure of the second to a certain extent We can not make any such definite statement about what will happen if we add a third liquid to the other two The addition of the third liquid may decrease the partial pressures of both the other liquids or it may decrease the partial pressure of either one and increase that of the other We must know the specific properties of the liquids before we can predict what will happen

We know that an irritating substance is often removed from the stomach by vomiting, but if we administer poison continuously for a long time, the system tends to eliminate the irritating effect by becoming immune to the poison We need not hark back to the mythical case of Mithridates, who qualified for the throne by living on all the known poisons while young The case of the arsenic eaters is better authenticated[6] The whole of immuno-chemistry is an illustration of the applicability of our law[7]

The most interesting field for the study of our law is to be found in the natural history sciences. Here we must consider the survival of the race as well as the survival of the individual or we shall make

[3] Brunton, St Louis Congress of Arts and Sciences, 6, 176, 1904

[4] "Chemical Pathology," 2, 1902.

[5] St Louis Congress of Arts and Sciences, 6, 174, 1904

[6] Brunton, St Louis Congress of Arts and Sciences, 6, 177, 1904

[7] Cf Le Dantec, "La Stabilité de la Vie," 25, 1910

serious mistakes. Thus plants and trees often flower at an abnormal time after receiving serious injury.[8] This is really one form of tendency to eliminate the disturbing factor. One should also distinguish between the direct injury to the plant or animal and the change in the organism which enables it or its descendants to withstand the disturbing influences.

A great deal has been done in the way of collecting facts illustrating the effect of environment on plants and animals but the real reason for any particular change is rarely given,[9] and the change is only too often the resultant of two or more factors which are *not* differentiated carefully. I am going to cite some cases in which the application of the theorem of Le Chatelier is quite clear, and also others which seem interesting enough to warrant attention being called to them.

PRESSURE AND CONCENTRATION

The wind blows against the trees and the boughs bend so as to spill the wind. A prevailing wind from a given direction causes the trees to assume a permanent set. This is not especially interesting because this change is probably not inherited to any appreciable extent.

Bailey[10] has pointed out that plants tend to become circular instead of bilateral, because they are sessile.

They therefore found it to their advantage to reach out in every direction from their support in the search for food. Whilst the centrifugal arrangement has strongly tended to disappear in the animal creation, it has tended with equal strength to persist and to augment itself in the plant creation. Its marked development amongst plants began with the acquirement of terrestrial life, and with the consequent evolution of the asexual or sporophytic type of vegetation. Normally, the higher type of plant bears its parts more or less equally upon all sides, and the limit to growth is still determined by the immediate environment of the given individual or of its recent ancestors. Its evolution has been acephalic, diffuse or headless, and the individual plant or tree has no proper concentration of parts. For the most part it is filled with unspecialized plasma, which, when removed from the parent individual (as in cuttings or grafts), is able to reproduce another like individual. The arrangements of leaves, branches, the parts of the flower, and even of the seeds in the fruit, are thus rotate or circular, and in the highest type of plants the annual increments of growth are disposed in like fashion, and it is significant to observe that in the compositæ, which is considered to be the latest and highest type of plant-form, the rotate or centrifugal arrangement is most emphatically developed. The circular arrangement of parts is the typical one for higher plants, and any departure from this form is a specialization, and demands explanation.

In England rabbits are held in check, though with some difficulty. If the repressive factors are removed, as in Australia, the rabbits adapt themselves to the situation and multiply so as to become a veritable pest. In the same way the Russian thistle spread through the northwest some years ago. An insect will often adapt itself to changed conditions to such an extent as to take on new habits.[11]

An early naturalist traveling in Colorado found a striped beetle feeding upon wild solanums or nightshades. The insect came to be in demand among collectors, and it is said that handsome prices were paid for specimens for museums. In the course of time the settlers grew potatoes in Colorado and the insect took a fancy to them and spread rapidly. It is now known as the Colorado potato beetle. The first attacks were noticed about thirty years ago, but now the insect is a serious pest wherever potatoes are grown in quantity.

[8] Möbius, "Lehre von der Fortpflanzung der Gewächse," 6, 122, 1897.

[9] Cf. Bailey, "The Survival of the Unlike," 32, 1896; MacDougal, *Memoirs N. Y. Bot. Garden*, 2, 1, 1903; Crozier, "The Modification of Plants by Climate," 1885; Eimer, "Organic Evolution," 1890.

[10] "The Survival of the Unlike," 15, 1896.

[11] Cf. Bailey, "The Survival of the Unlike," 184, 1896.

The displacement of equilibrium due to cultivating large areas to one crop has led to an enormous increase in the number of insects and fungous enemies in any given region.[12]

The excessive ravages of insects in the United States are largely owing to the cultivation of their food plants in extended areas Two hundred years ago not even the wild crab, the earliest representative of the apple, existed in this country, and consequently there were no apple insects Later when a few apple trees became the adjunct of the simple homes of the early settlers, those of our insects to which they offered more desirable food than that on which they had previously subsisted were obliged to wing their way often for many miles in search of a tree on which to deposit their eggs. If birds were then abundant, how few of the insects could accomplish such extended flights! But in the apple orchards of the present day—some of them spreading in almost unbroken mass of foliage over hundreds of acres—our numerous apple insects may find the thrifty root, the vigorous trunk, the succulent twig, the tender bud, the juicy leaf, the fragrant blossom, and the crisp fruit spread out before them in broad array, as if it were a special offering to insect voracity, or a banquet purposely extending an irresistible invitation. . . . Careful cultivation has made it the best of its kind, appetite is stimulated, development is hastened, broods are increased in number, individuals are multiplied beyond the conservation of parasitic destruction, facilities of distribution are afforded with hardly a proper exercise of locomotive organs; and when these almost useless members have become absorbed, as in the wingless females of the bark-louse and the canker worms, the interlocking branches afford convenient passage from tree to tree

As Bailey[13] says:

We, as horticulturists, are every year planting new invitations to insect and fungous attacks. If we take this extra risk, we must certainly prepare ourselves to meet it Our fathers' weapons can not avail against the hords of invaders which we are inviting to our doors. They are coming up out of the woods and the swamps and the bare fields to regale themselves at the banquet which we have spread.

Cultivation affords places of less struggle than organisms are forced to occupy under normal conditions. Man disturbs the equilibrium or removes the pressure in some direction, and a multitude is waiting to spring into the void The great potato fields not only provided food, but there were few other insects to dispute the possession of them, the Colorado solanum beetle saw his opportunity, and improved it He has been a successful bug This release of the natural tension, which cultivation affords, is to my mind the most potent factor in the increase of our little foes

TEMPERATURE

One effect of a lower temperature is obviously to produce a better protective coating on animals, while a higher temperature acts in the opposite way I quote a few special cases from Darwin [14]

According to Roulin, the semi-feral pigs in the hot valleys of New Granada are very scantily clothed, whereas, on the Paramos, at the height of 7,000 to 8,000 feet, they acquire a thick covering of wool lying under the bristles, like that on the truly wild pigs of France

Roulin asserts that the hides of the feral cattle on the hot Llanos are always much less heavy than those of the cattle raised on the high platform of Bogota, and that these hides yield in weight and in thickness of hair to those of the cattle which have run wild on the lofty Paramos The same difference has been observed in the hides of cattle reared on the bleak Falkland Islands and on the temperate Pampas

Great heat seems to act directly on the fleece several accounts have been published of the change which sheep imported from Europe undergo in the West Indies. Dr Nicholoson, of Antigua, informs me that, after the third generation, the wool disappears from the whole body, except over the loins, and the animal then appears like a goat with a dirty door mat on its back A similar change is said to take place on the west coast of Africa. On the other hand, many wool-bearing sheep live on the hot plains of India. Roulin asserts that in the lower and heated valleys of the Cordillera, if the lambs are sheared as soon as the wool has grown to a certain thickness, all goes

[12] Lintner, First Report State Entom. N. Y, 10, 1882.

[13] "The Survival of the Unlike," 187, 1896.

[14] "Animals and Plants under Domestication," 2d ed., 1, 81, 95, 102, 1890.

on afterwards as usual; but if not sheared, the wool detaches in flakes, and short shining hair like that of a goat is produced afterwards This curious result seems merely to be an exaggerated tendency natural to the Merino breed, for as a great authority, namely, Lord Somerville, remarks, "the wool of our Merino sheep after shear time is hard and coarse to such a degree as to render it almost impossible to suppose that the same animal could bear wool so opposite in quality, compared to that which has been clipped from it, as the cold weather advances, the fleeces recover their soft quality" As in sheep of all breeds the fleece naturally consists of longer and coarser hair, covering shorter and softer wool, the change which it often undergoes in hot climates is probably merely a case of unequal development; for even with those sheep which like goats are covered with hair, a small quantity of underlying wool may always be found In the wild mountain sheep (*Ovis montana*) of North America there is an analogous change of coat;[15] the wool begins to drop out in early spring, leaving in its place a coat of pelage quite different in character from the ordinary thickening—for instance, in the horse, the cow, etc, which shed their winter coat in the spring.

The fact of there being wool-bearing sheep in the hot plains of India is not necessarily a contradiction of the general law, because the tendency to change may be counteracted by careful selection [16]

M Lasterye, after discussing this subject, sums up as follows: "The preservation of the Merino race in its utmost purity at the Cape of Good Hope, in the marshes of Holland, and under the rigorous climate of Sweden, furnishes an additional support of this my principle, that fine-wooled sheep may be kept wherever industrious men and intelligent breeders exist.

If we remove a plant to a climate where frosts occur earlier, the chances are very good that the plant will be killed before the seeds ripen. If the variety is to survive, an early-ripening form must develop This actually happens with wheat.[17]

[15] Audubon and Bachman, "The Quadrupeds of North America," 5, 365, 1846.

[16] Darwin, "Animals and Plants under Domestication," 2d ed., 1, 103, 1890.

[17] Darwin, "Animals and Plants under Domestication," 2d ed., 1, 333, 1890.

Wheat quickly assumes new habits of life. The summer and winter kinds were classed by Linnæus as distinct species; but M Monnier has proved that the difference between them is only temporary. He sowed winter wheat in the spring, and out of one hundred plants four alone produced ripe seeds; these were sown and resown, and in three years plants were reared which ripened all their seed. Conversely, nearly all plants raised from summer wheat, which was sown in autumn, perished from frost; but a few were saved and produced seed, and in three years this summer variety was converted into a winter variety Hence it is not surprising that wheat soon becomes to a certain extent acclimatised, and that seed brought from distant countries and sown in Europe, vegetates at first or even for a considerable period, differently from our European varieties In Canada the first settlers, according to Kalm, found their winters too severe for winter wheat brought from France, and their summers often too short for summer wheat, and they thought that their country was useless for corn crops until they procured summer wheat from the northern part of Europe, which succeeded well

Another interesting case is that of corn, also cited by Darwin.[18]

The tall kinds grown in southern latitudes, and therefore exposed to great heat, require from six to seven months to ripen their seed; whereas the dwarf kinds, grown in northern and colder climates, require only from three to four months. Peter Kalm, who particularly attended to this plant, says, that in the United States in proceeding from south to north, the plants steadily diminish in bulk. Seeds brought from lat. 37° in Virginia, and sown in lat. 43°–44° in New England, produce plants which will not ripen their seed, or ripen them with utmost difficulty. So it is with seed carried from New England to lat. 45°–47° in Canada. By taking great care at first, the southern kinds after some years' culture ripened their seed perfectly in their northern homes, so that this is an analogous case with that of the conversion of summer into winter wheat, and conversely. When tall and dwarf maize are planted together, the dwarf kinds are in full flower before the others have produced a single flower, and in Pennsylvania they ripen their seeds six weeks earlier than the tall maize. Metzger also mentions a European maize which

[18] "Animals and Plants under Domestication," 2d ed., 1, 341, 1890.

ripens its seed four weeks earlier than another European kind. With these facts so plainly showing inherited acclimatisation, we may readily believe Kalm, who states that in North America maize and some other plants have gradually been cultivated further and further northward.

The peach tree offers another good instance of acclimatization.[19]

Mr Crozier records testimony to the effect that peach trees in Michigan were injured no more at a temperature of twenty degrees below zero than they were in central Mississippi at a temperature of zero. Peach buds are injured at a much higher temperature at the south than at the north. Mr P. H. Mell, Jr., director of the Alabama Polytechnic Institute at Auburn, writes me that buds are often killed even at a temperature of 34 to 38 degrees above zero. This observation undoubtedly refers to the partially expanded buds, yet it is well known that at the north a considerable frost is required to kill the swelling buds. It is possible that all these instances of the peach should fall under the division of adaptation through modification of individual constitution, but as I can not be certain, if indeed it is probable, that all these cases represent bud offspring, I place the statement here. If trees of the same variety show this difference in different latitudes, as they undoubtedly often do, then we have indisputable evidence of the acclimatizing of the individual.

Bailey's quotation from Cooper as to watermelons also has a bearing on this matter.[20]

A striking instance of plants being naturalized happened by Colonel Matlack sending some watermelon seed from Georgia, which, he informed me [Cooper] by letter, were of superior quality. Knowing that seed from vegetables which had grown in more southern climates required a longer summer than what grew here, I gave them the most favorable situation, and used glasses to bring them forward, yet very few ripened to perfection, but finding them to be so excellent in quality as described, I saved seed from those first ripe; and by continuing that practise four or five years, they became as early watermelons as I ever had.

Changes in the colors of some butterflies can be obtained by varying the temperature during the pupal stage of development. While we are not able to prove that these changes are beneficial adaptations, it is interesting to note that these changes characterize the same butterflies in arctic and tropic regions.[21]

Warmth acting on pupæ of *V. Cardui* (painted lady), gave an extraordinarily pale form, like those found in very different parts of the tropics. Cold, on the other hand, gave specimens with a very recognizable darkening of the whole insect, such as is exhibited by a form found in Lapland.

We have no clue[22] at all as to the influence a low temperature has upon the production of wings in aphides. "As long as the temperature is high and the moisture sufficient, plant lice are wingless, but if the temperature be lowered, wings begin to grow." The problem is an interesting one and should not be difficult to solve with the aid of the theorem of Le Chatelier.

LIGHT

Since light tends to destroy any substance which absorbs it, it seems at first sight as though transparent, colorless plants and animals would be the surviving type in the intense light of the tropics. Light does tend to bleach organic colors, but the flaw in the reasoning is that we are dealing with living organisms.[23] It is easier for a man or an animal to develop a pigmented coating and thus eliminate the chemical action of light on blood[24] than for it to acquire the habit of living without red corpuscles. It is evidently better for a plant to develop chlorophyll and a healthy

[19] Bailey, "The Survival of the Unlike," 325, 1896.

[20] Bailey, "The Survival of the Unlike," 154, 1896.

[21] Vernon, "Variations in Plants and Animals," 237, 1903.

[22] Loeb, "The Dynamics of Living Matter," 112, 1906.

[23] Cf. Eimer, "Organic Evolution," 136, 1890.

[24] Cf. Woodruff, "Effects of Tropical Light on White Men," 10, 35, 1905.

appetite for carbon dioxide than for it to be bleached by the light.

Consequently we find that man is invariably covered with a pigment which acts as an armor to exclude the more harmful short rays, and moreover the amount of pigment is in direct proportion to the intensity of the light of the country to which his ancestors have proved their adjustment by centuries or millenniums of survival in health and vigor. It is a simple matter of mathematics to show that the intensity of light under the zenith sun in the tropics is the greatest, and that the amount of rays per unit of surface diminishes as we go north in proportion to a function of the latitude. In addition to this, the further from the tropics we go the greater is the layer of air which the rays must pass through and the more of them which are absorbed. Hence we can reach a latitude where there is insufficient light for plant growth even if there could be sufficient warmth. Yet man flourishes in these regions, and so do other animals. Hence we find the greatest pigment in the tropics among the Australians, New Guineas, Negritos, East Indians and African Negroes, some of whom are nearly jet black. As we go north from the tropics we find the complexions gradually lightening, being dark brown in Egypt, light brown in north Africa states, deep olive in the Mediterranean, olive in southern Europe, brunette in central Europe and blond in the northwestern sections of Europe, embraced by a curve passing through northern France, northern Germany and northwest Russia.

Undoubtedly the negro, while in the shade, is able to radiate heat better than whites, and this enables him to keep cool in the tropics, but puts him at a disadvantage in the north where the white man can keep warmer with less clothing and less fire in the house. But it is a secondary cause enhancing the first, because when it comes to a question of light and cold, nature makes no mistakes, but selects a color able to exclude the light. Hence in all cold light countries, *i. e.*, steppes, plains, and the arctics, there is a pigmentation of a color in the lower end of the spectrum, red or yellow, with variations of brown, olive or copper. As a rule the color is markedly light yellow in cold, light countries, as in North China.

In America we had every shade from the blackest Indians of tropical South America through all the shades of copper and brown to the very light, almost white Indians of the northeastern part of the United States, who had conditions very similar to those suited for the blonds of Europe. In Italy, Spain and China, we find the same thing, for the men of the south are markedly darker than those of the north.

The same law holds in France, Germany, Russia, Persia and India: the north is decidedly blonder than the south, and the same is found in the British Islands, but in a much modified way. Even the Ainos in the north of Japan are said to be lighter than the Japanese.

All these red and yellow colors undoubtedly enable the native to conserve his heat almost as well as the white man, and at the same time exclude the dangerous short waves.

In Africa, Eimer[25] found that in passing up the Nile valley from the Delta to the Soudan, the natives gradually became more and more dark-skinned the further south they lived.

Woodruff[26] recommends that white men in the tropics should wear white outer garments and black underclothes, which constitutes a pretty fair imitation of a dark-skinned Arab in a white burnous.

Vernon[27] points out "that the diminution or disappearance of pigmentation following upon withdrawal of light, is best illustrated by reference to the well-known cave animals. Of these, one of the most interesting is *Proteus anguineus*, which is found in the subterranean caves of the Karst Mountains about Adelsberg. This amphibian is almost white, but if kept for some time in the light, it gradually becomes pigmented. Pigment cells are, in fact, still present in its skin, and in all probability these are directly stimulated to exert their function by the action of the light." If Vernon had been familiar with the theorem of Le Chatelier, he would have worded this last sentence very differently.

In the case of heliotropism, the animals

[25] "Organic Evolution," 88, 1890.

[26] "Effects of Tropical Light on White Men," 321, 1905.

[27] "Variation in Animals and Plants," 250, 1903.

turn automatically to or from the source of light, depending on whether they are positively or negatively heliotropic In some cases they also move automatically towards or away from the light Loeb[28] says in regard to this·

This automatic orientation is determined by two factors, first a peculiar photo-sensitiveness of the retina (or skin), and second a peculiar nervous connection between the retina and the muscular apparatus In symmetrically built heliotropic animals in which the symmetrical muscles participate equally in locomotion, the symmetrical muscles work with equal energy as long as the photo-chemical processes in both eyes are identical If, however, one eye is struck by stronger light than the o her, the symmetrical muscles will work unequally and in positively heliotropic animals those muscles will work with greater energy which bring the plane of symmetry back into the direction of the rays of light and the head towards the source As soon as both eyes are struck by the rays of light at the same angle, there is no more reason for the animal to deviate from this direction and it will move in a straight line All this holds good on the supposition that the animals are exposed to only one source of light and are very sensitive to light.

Loeb[29] has also shown that the heliotropism may sometimes be modified or even reversed by adding certain chemicals to the water He has also shown[30] that some animals seek automatically the places where the intensity of light is a minimum, but that this is not negative heliotropism because the animals do not necessarily move along the path of the ray In all these cases we have an application of our law, because the animals arrange themselves so as to minimize the state of stress

It had always seemed to me a most mysterious thing that animals should be heliotropic, until it finally dawned on me that we are all of us heliotropic to a certain extent. Place a man out in an intense light and, if he can not shade his eyes, it will take a pretty strong special stimulus to keep him from turning his back to the light If his eyes happen to be weak, he will respond more promptly and more automatically to the light He is negatively heliotropic to strong light. I am inclined to think that man is positively heliotropic to a faint light, because he would certainly tend to turn towards the point that he could see We can also find an analogy to the case of the animals which congregated at the places where the intensity of light is a minimum Place a man out on the desert in blazing sunlight and it will take a strong counter-stimulus to keep him from moving into any shade that he can find Here the irritation is due to heat and not to light; but the man is not negatively thermotropic because he will move across the temperature gradient in order to reach the shade

Of course the reflex action is not relatively so powerful with man as with the lower animals. In fact, Loeb[31] says that "it rarely happens that animals endowed with the mechanisms of associated memory react in such a machine-like manner to the elementary forces of nature as the heliotropic animals which we have discussed"

Vernon[32] points out that

If plants be allowed to grow in absolute darkness, they, as a rule, become very much elongated in form whilst their leaves are small and ill shaped . Sachs found that potato tubers grown in darkness for fifty-three days produced sprouts from 150 to 200 mm high, whilst similar ones grown in daylight were only 10 to 13 mm. high Again he found that the hypocotyl of the buckwheat (*Fagopyrum*) reached a height of 35 to 40 cm. in the dark, whilst it grew only to 2 or 3 cm when freely exposed to light. K. Goebel

[28] "Darwin and Modern Science," 264, 1909

[29] "The Dynamics of Living Matter," 131, 1906, "Darwin and Modern Science," 265, 1909.

[30] Loeb, "The Dynamics of Living Matter," 136, 1906.

[31] "The Dynamics of Living Matter," 135, 1906

[32] "Variation in Animals and Plants," 245, 1903.

has shown that if cactuses are cultivated in darkness, their form changes completely. The young shoots are rounded, and fail to show the angular irregularities of form which increase the surface capable of effecting assimilation under the influence of light

Since the leaves especially are effective in the light, the absence of light will prevent normal development of the leaves and this seems to be the chief direct effect If the plant does not have to develop leaves to any extent, there is more food available for the stem; and the growth of the stem is thus really a secondary effect The matter is still further complicated by the fact that the moisture content and the carbon dioxide content of the air were not kept constant during the two sets of experiments

An increase in the intensity of the light is often accompanied by a decrease in the surface of the leaf and an increase in the thickness [33] I think that it is a mistake to attribute this change to the action of light alone It is more the combined effect of light and dryness, or of light and the higher rate of evaporation due to a higher temperature With decreased surface and greater thickness there is less evaporation, one extreme of which is reached in the eucalyptus with its leaves turned edgewise. The assimilation of food is provided for by an increased thickness of the chlorophyll layer, because the more intense light can penetrate farther into the leaf

We have seen that the pigment in the negro's skin is essentially protective in action A thicker or coarser leaf may also be a protection against too intense a light Rowlee[34] found that "intense light does not kill thick, coriaceous or succulent leaves with heavy cutinized external walls . . . doubtless owing to the screening effect of the heavy walls or cells containing much water."

We have not sufficient data to make it possible to say why an increase in the intensity of light causes the change from sexual to asexual reproduction in some algæ and the reverse change in others,[35] but we can be quite certain that both changes are in conformity with the theorem of Le Chatelier.

MOISTURE

Vernon[36] says that "the effect of a dry soil and atmosphere is well shown by the characters of desert plants These are stunted in growth, and are of a nearly uniform gray color, owing to their intense hairiness. The leaves are more fleshy, and there is a great tendency to the formation of spines. That these characters are in part at least the direct result of want of water is shown by the fact that they may disappear if water is supplied." The development of hairs is of great advantage to a plant in an arid climate, especially if there is any wind The circulation of air, and consequently the rate of evaporation is impeded by the mass of hairs

We get characteristic changes when plants, normally terrestrial, are grown in water.[37]

As regards the leaves, it is well known that when aerial and floating leaves are present on the same aquatic plant, they differ greatly in structure, and as a rule also in form, from the submerged leaves. In *Ranunculus heterophyllus* and *Cabomba aquatica*, for instance, the floating leaves are more or less rounded, whilst the submerged ones have dissected and filiform segments In *Hippuris* (mare's tail) the aerial and floating leaves are short, and in *Callitriche* rounded, but

[33] Vernon, "Variation in Animals and Plants," 248, 1903.

[34] Proc. 19th Meeting Soc Promotion Agric. Science, Boston, 1898.

[35] Loeb, "Darwin and Modern Science," 230, 1909.

[36] "Variation in Animals and Plants," 263, 1903.

[37] Cf. Vernon, "Variation in Animals and Plants," 266, 1903

the submerged leaves of both are linear or ribbon-like. In all cases the submerged leaves are of a more delicate texture, more or less translucent, and of a brighter green color than the others.

This is a much more complex case than Vernon realizes. Submerged leaves do not develop the supporting frame of the aerial leaves. The delicate texture is therefore to a great extent a result of the supporting power of the water and not of its wetness. Since the supporting structure of the aerial leaf is not developed when the leaf is submerged, the leaf grows longer, just as the stem of the plant grows longer in the dark because the leaves develop but slightly. The thinness of the leaf is probably chiefly a result of the decreased intensity of light. This is the best analysis that can be given at present, but it brings out clearly how slack people have been in controlling conditions.

The effect of excessive moisture or aridity upon plants is similar in type[38] to the effect of heat or cold on the pupæ of butterflies.

The relation of leaf form to environment has often been investigated and is well known. The leaves of bogs and water-plants afford the most striking examples of modifications: according as they are grown in water, moist or dry air, the form of the species characteristic of the particular habitat is produced, since the stems are also modified. To the same group of phenomena belongs the modification of the forms of leaves and stems in plants or transplantation from the plains to the mountains or *vice versa*. Such variations are by no means isolated examples. All plants exhibit a definite alteration in form as the result of prolonged cultivation in moist or dry air, in strong or feeble light or in darkness, or in salt solutions of different composition and strength.

The last sentence in the preceding paragraph is interesting for what it does not say. There is no indication that Klebs has any inkling of the universal law underlying all these changes.

[38] Klebs, "Darwin and Modern Science," 235, 1909.

FOOD AND FERTILIZERS

It seems evident that an exuberant growth would be favorable to variability and to the development of sports. This is universally recognized to be the case. Thus Darwin[39] says:

Of all the causes which induce variability, excess of food, whether or not changed in nature, is probably the most powerful. This view was held with regard to plants by Andrew Knight and is now held by Schleiden, more especially in reference to the inorganic elements of the food. In order to give a plant more food, it suffices in most cases to grow it separately, and thus prevent other plants robbing its roots. It is surprising, as I have often seen, how vigorously our common wild species flourish when planted by themselves, though not in highly manured land; separate growth is, in fact, the first step in cultivation, we see the converse of the belief that excess of food induces variability in the following statement by a great raiser of seeds of all kinds: "It is a rule invariably with us, when we desire to keep a true stock of any one kind of seed, to grow it on poor land without dung, but when we grow for quantity we act contrary, and sometimes have dearly to repent of it." According also to Carrière, who had great experience with flower-garden seeds, "On remarque en général les plantes de vigeur moyenne sont celles qui conservent le mieux leurs caractères."

Under the heading of effect of cultivation, Klebs[40] says:

It is however a fact that if a plant is removed from natural conditions into cultivation, a well-marked variation occurs. The well-known plant breeder, L. de Vilmorin, speaking from his own experience, states that a plant is induced to *affoler*, that is, to exhibit all possible variations from which the breeder may make a further selection only after cultivation for several generations. The effect of cultivation was particularly striking in *Veronica chamaedrys*, which, in spite of its wide distribution in nature, varies very little. After a few years of cultivation this "good" and constant species becomes highly variable. The specimens on which the experiments were made were three modified inflorescence cuttings, the

[39] "Animals and Plants under Domestication," 2d ed., 2, 214, 1890.

[40] "Darwin and Modern Science," 245, 1909.

parent plants of which certainly exhibited no striking abnormalities In a short time many hitherto latent potentialities became apparent, so that characters, never previously observed, or at least very rarely, were exhibited, such as scattered leaf arrangements, torsion, terminal or branched inflorescences, the conversion of the inflorescence into foliage shoots, every conceivable alteration in the color of flowers, the proliferation of flowers.

One more quotation will suffice, this time from Bailey [41]

Now let us endeavor to put ourselves in nature's place, if such a conception is possible, and to briefly follow an outline of her methods with plants. We shall find that variation is largely the result, so far as we can see, of excess of food supply. The seedsman knows that heavy lands make his seed crops break into non typical forms, and he therefore prefers, for most plants, a soil not very rich in nitrogen or growth production Heavy soils make the dwarf peas "viney," and bud sprouts of curious leaves and flowers are wont to appear upon over vigorous shoots

Since conditions which tend to shorten the life of a plant or tree often cause the plant or tree to flower,[42] it follows that conditions which favor a rank growth are likely to be disadvantageous to the production of flowers This is actually the case [43]

One extreme case, that of exceptionally early flowering, has been observed in nature and more often in cultivation. A number of plants under certain conditions are able to flower soon after germination. This shortening of the period of development is exhibited in the most striking form in trees, as in the oak,[44] flowering seedlings of which have been observed from one to three years old, whereas normally the tree does not flower until it is sixty or eighty years old

Another extreme case is represented by prolonged vegetative growth leading to the complete suppression of flower-production. The result may be obtained with several plants, such as *Glechoma*, the sugar beet, *Digitalis*, and others, if they are kept during the winter in a warm, damp atmosphere, and in rich soil, in the following spring or summer they fail to flower Theoretically, however, experiments are of greater importance in which the production of flowers is inhibited by very favorable conditions of nutrition occurring at the normal flowering period Even in the case of plants of *Sempervivum* several years old, which, as is shown by control experiments on precisely similar plants, are on the point of flowering, flowering is rendered impossible if they are forced to very vigorous growth by an abundant supply of water and salts in the springs Flowering, however, occurs, if such plants are cultivated in relatively dry soil and in the presence of strong light. Careful researches into the conditions of growth have led, in the case of *Sempervivum*, to the following results (1) With a strong light and vigorous carbon assimilation in strong light, a considerably increased supply of water and nutritive salts produces active vegetative growth (2) With vigorous carbon assimilation in strong light, and a decrease in the supply of water and salts, active flower production is induced. (3) If an average supply of water and salts is given, both processes are possible; the intensity of carbon assimilation determines which of the two is manifested A diminution in the production of organic substances particularly of carbohydrates, induces vegetative growth This can be effected by culture in feeble light or in light deprived of the yellow-red ray on the other hand, flower-production follows increase in light intensity These results are essentially in agreement with well known observations on cultivated plants, according to which, the application of much moisture, after a plentiful supply of manure composed of inorganic salts, hinders the flower production of many vegetables, while a decrease in the supply of water and salts favors flowering

Good manuring is in the highest degree favorable to vegetative growth, but is in no way equally favorable to the formation of flowers The constantly repeated expression, good or favorable nourishment, is not only vague but misleading, because circumstances favorable to growth differ from those which promote reproduction; for the production of every form there are certain favorable conditions of nourishment, which may be defined for each species. Experience shows

[41] "The Survival of the Unlike," 169, 1898

[42] Möbius, "Beiträge zur Lehre von der Fortpflanzung der Gewächse," 7, 125, 1897

[43] Klebs, "Darwin and Modern Science," 232, 246, 1909

[44] Möbius, "Beiträge zur Lehre von der Fortpflanzung der Gewächse," 89, 1897 [The conditions are not given by Möbius —W. D B]

that, within definite and often very wide limits, it does not depend on the *absolute amount* of the various food substances, but upon their respective degrees of concentration As we have already stated, the production of flowers follows a relative increase in the amount of carbohydrates formed in the presence of light, as compared with the inorganic salts on which the formation of albuminous substances depends[44] The various modifications of flowers are due to the fact that a relatively too strong solution of salts is supplied to the rudiments of these organs. As a general rule every plant form depends upon a certain relation between different chemical substances in the cells and is modified by an alteration of that relation

Vernon[45] cites some interesting cases in which changes of diet have apparently produced results in accordance with our law

John Hunter observed a most marked thickening and hardening in the stomach of a gull (*Larus tridactylus*) which had been fed for a year on grain It is stated by Dr Edmonston that a similar change takes place under natural conditions every year in the stomach of the common herring gull (*Larus argentatus*) Thus in the Shetland Islands this bird feeds in the winter on fish, but in the summer frequents the cornfields and feeds on grain Dr Edmondston has also noticed a somewhat similar change in the stomach of a raven which had been fed for a long time on vegetable food Again, Menetries found that in an owl (*Strix Gallaria*) the effect of vegetable diet was to change the form of the stomach and make the inner coat leathery.

The converse experiment of feeding graminivorous birds on a flesh diet has been made by Dr Holmgren By feeding pigeons on meat for a considerable time, he found that the gizzard gradually acquired the qualities of a carnivorous stomach Again Delage fed a fowl for three years on meat, and found that the muscular substance of its gizzard was considerably decreased. All these results, though apparently so unequivocal, have not passed unchallenged; for G. Brandes,[47] who fed both flesh-feeding birds on grain, and grain feeders on flesh, states that he was unable to trace any adaptation to the altered conditions in either case.

Since these alleged changes are directly in line with the cases previously quoted, of the changes in butterflies and bog plants, it seems probable that the negative results are due to error. It is very desirable, however, that this point should be settled definitely one way or the other.

A very complicated case of the effect of the environment, and one which I shall *not* attempt to account for, is cited by Poulton[48]

Entirely new light upon the seasonal appearance of epigamic characters is shed by the recent researches of C W. Beebe,[49] who caused the scarlet tanager (*Piranga erythromelas*) and the bobolink (*Dolichonyx oryzivorus*) to retain their breeding plumage through the whole year by means of fattening food, dim illumination and reduced activity Gradual restoration to the light and the addition of meal-worms to the diet invariably brought back the spring song, even in the middle of winter A sudden alteration of temperature, either higher or lower, caused the birds nearly to stop feeding, and one tanager lost weight rapidly and in two weeks moulted into the olive-green winter plumage. After a year, and at the beginning of the normal breeding season, "individual tanagers and bobolinks were gradually brought under normal conditions and activities"; and in every case moulted from nuptial plumage to nuptial plumage "The dull colors of the winter season had been skipped" The author justly claims to have established "that the sequence of plumage in these birds is not in any way predestined through inheritance . .," but it may be interrupted by certain factors in the environmental complex.

SECRETIONS

Under physiology and medicine mention has previously been made that many organisms give rise to products which are toxic to the organism and which must be removed. Brunton[50] points out that "an excessive quantity of their own products is usually injurious to cells and too much alcohol will stop the growth of yeast At

[44] Klebs, "Künstliche Metamorphosen," 117.

[45] "Variation in Animals and Plants," 295, 1903.

[47] Biol. Centralblatt, 16, 825.

[48] "Darwin and Modern Science," 297, 1909.

[49] *The American Naturalist*, 42, 34, 1908.

[50] "Darwin and Modern Science," 174, 1909.

the same time these products are frequently very nutritious for cells of a different sort and alcohol furnishes a most suitable pabulum for the organisms which produce vinegar. Vinegar in its turn is toxic to the microbe which produces it, but serves again as a soil for another which gives rise to a viscous fermentation. By the successive action of these ferments a solution of sugar may produce, first, alcohol, secondly, vinegar, and thirdly, ropy mucus. In this particular series each microbe produces a substance injurious to itself but useful to its successor. This is, however, not always the case because a cell may produce a substance not only injurious to itself but injurious to other cells, and alcohol in large quantity not only kills the cells of yeasts, but other cells as well. Similar conditions occur within living organisms where the cells composing the different parts are connected together and pass on the products of their life from one cell to another by means of the circulation of the blood and tissue juices. The secretions of one part may be, and indeed generally are, useful to other parts of the organism and so long as no part sins, either by deficiency or excessive action, the whole organism maintains a condition of health. But this is not always the case and health may be destroyed by (*a*) excessive, (*b*) defective or (*c*) prevented action of one or more of the parts composing the body."

Vernon[51] has tested the influence of the excreta of adult echinoids upon larval growth.

Echinoids of known weight were kept for a known time in a known volume of water, so that, on determining the absolute effect produced on larvæ grown in this water it was possible to calculate the relative effect produced by unit weight of echinoids kept for unit time in unit volume of water. On growing larvæ in water previously fouled by adult echinoids of their own species, it was found that, as a mean of five observations, they were diminished in relative size by 2.6 per cent., whilst only 41 per cent. of the ova employed reached the larval stage. On growing them in water fouled by echinoids of other than their own species, the larvæ, as a mean of five observations, were diminished by only 1.9 per cent., whilst 54 per cent of the ova reached the larval stage. That is to say, the products of excretion of an echinoid act more adversely both on the death rate and on the growth of embryos if these belong to its own species than if they belonged to another species. At least this is the case with *Strongylocentrotus*, *Sphærechinus* and *Echinus*. With two other (physiologically) less closely related species, viz., *Arbacia pustulosa* and *Dorocidaris papillata*, it was even found that the products of excretion, so far from acting adversely on growth, actually favored it. Thus *Strongylocentrotus* larvæ grown in water fouled by these two species were increased in size by respectively 4.3 and 1.7 per cent., whilst respectively 81 and 50 per cent. of the ova employed reached the pluteus stage.

Vernon[52] points out also that "De-Varigny actually found that snails grown in water in which other snails had already been growing several months were distinctly smaller than those grown in fresh water, and if the excreta of snails had been added as well they were smaller still."

The experiments of Warren[53] show that water fouled by *Daphnia* becomes specifically injurious to *Daphnia*, "for when the *Daphnia* are fast disappearing, there may be a swarm of ostracods or copepods (still living healthily in the water)."

If we were to reason from these facts to the behavior of crops, such as wheat, for instance, we should conclude that wheat unquestionably secretes substances which are toxic to itself and that the development of that crop or of a subsequent one

[51] "Variation in Animals and Plants," 298, 1903.

[52] "Variation in Animals and Plants," 305, 1903.

[53] Vernon, "Variation in Animals and Plants," 309, 1903.

would depend in part on the degree of the accumulation of the toxic substances in the soil. If the toxic substances were removed or destroyed sufficiently rapidly, no deleterious result would occur, but, otherwise, there would be one We should also conclude that the secretions from the wheat would not necessarily be toxic to other crops These *a priori* predictions seem to be confirmed by the facts

Cameron[34] points out that

It has been found that as a general rule the continued growth of one crop in any soil results in a low crop production Pot cultures have given even more pronounced results in the same direction The explanation long accepted is that the soil has, as a result of the continued cropping, become deficient in one or more of the "available" mineral nutrients Pot experiments, where the garnered crop was returned to the soil and still diminished yield was obtained, throw doubt on this explanation. Still further doubt results from water cultures which, by growing a crop in them, become "poor" for subsequent crops, although there is maintained in them an ample supply of mineral plant nutrients, and they are easily renovated by good adsorbers. These facts find a more satisfactory explanation as being due to the production in the nutrient medium of deleterious organic substances originating in the growing plant itself. This idea seems to have been advanced first by De Candolle, in 1832, to account for the beneficial results obtained by employing a rotation of crops It appears to have been held by Liebig at one time, although he subsequently abandoned it in favor of the view that the benefits of a crop rotation are due to the several crops requiring different proportions of mineral nutrients, and that the disturbance of the balance in the soil produced by one crop is not unfavorable to the growth of some other crop. Although lacking direct experimental confirmation, this latter view of Liebig's has long prevailed among agricultural investigators, partly by reason of his authority, partly by reason of the dominance of the plant food theory of fertilizers, and partly by reason of the fact that the ideas of De Candolle, as originally advanced, include certain errors soon detected The trend of recent investigations has been distinctly in favor of a modified form of the view of De Candolle It has been recognized that other factors enter into crop rotations, such as the elimination of associated weeds, various kinds of animal, insect and plant parasites, preparation of the soil by a deep-rooted crop for a shallow-rooted following crop, etc It has come to be recognized that there are natural associations of plants and natural rotations of vegetation certainly determined by other than plant food factors Thus, in the eastern United States, wheat is followed by ragweed naturally, while, across the fence cocklebur and wild sunflowers come in after the corn, the difference in vegetation being as sharply marked after the removal of the crops as when they still occupied the land Analyses of the ragweed, for instance, although it is a shallower rooted crop than wheat, show that it takes from the soil as much of the mineral nutrients as does the preceding wheat crop The investigation of Lawes and Gilbert on fairy rings showed that the continual widening of the rings can not be satisfactorily explained by the comparison of the mineral constituents in the soil within and without the rings. Work at Woburn on the effect of grass on apple trees finds no other plausible explanation than that the growing grass produces in the soil organic substances detrimental to young apple trees A number of similar cases have been recorded

[34] *Jour. Phys. Chem.*, 14, 425, 1910

CLIMATE

When seeds are planted in a new locality, a great many conditions are varied simultaneously and it is difficult, usually impossible, to tell to what extent each factor causes the changes that actually take place or why any given change is beneficial If we compare two varieties of the same plant, it seems reasonable to suppose, unless proof to the contrary is given, that the local variety is fairly well adapted to the local conditions, in which case one would expect the foreign variety to vary towards the local one Darwin[35] cites a case of this sort.

The effects of climate of Europe on the American varieties [of maize] is highly remarkable Metzger obtained seed from various parts of

[35] "Animals and Plants under Domestication," 2d ed., 1, 340, 1890.

America, and cultivated several kinds in Germany I will give an abstract of the changes observed in one case, namely, with a tall kind (*Breit-kornger Mais, Zea altissima*) brought from the warmer parts of America During the first year the plants were twelve feet high, and a few seeds were perfected, the lower seeds in the ear kept true to their proper form, but the upper seeds became slightly changed. In the second generation the plants were from nine to ten feet in height, and ripened their seed better, the depression on the outer side of the seed had almost disappeared, and the original beautiful white color had become duskier Some of the seeds had even become yellow, and in their now rounded form they approached common European maize. In the third generation nearly all resemblance to the original and very distinct American parent-form was lost In the sixth generation this maize perfectly resembled a European variety, described as the second sub-variety of the fifth race When Metzger published his book, this variety was still cultivated near Heidelberg, and could be distinguished from the common kind only by a somewhat more vigorous growth

Bailey[56] draws the following conclusion in regard to American fruits and American climate

American fruits constantly tend to diverge from the foreign types which were their parents, and they are, as a rule, better adapted to our environments than foreign varieties are In less than a century we have departed widely from the imported varieties which gave us a start At the expiration of another century we should stand upon a basis which is nearly if not wholly American

Darwin[57] notes a similar case.

Mr Meehan has compared twenty nine kinds of American trees with their nearest European allies, all grown in close proximity and under as near as possible the same conditions. In the American species he finds, with the rarest exceptions, that the leaves fall earlier in the season and assume before their fall a brighter tint; that they are less deeply toothed or serrated; that the buds are smaller, that the trees are more diffuse in growth and have fewer branchlets, and lastly, that the seeds are smaller—all in comparison with the corresponding European species. Now considering that these corresponding trees belong to different orders, and that they are adapted to widely different stations, *it can hardly be supposed that their differences are of any special service to them in the new and old worlds,*[58] and, if so, such differences can not have been gained through natural selection, and must be attributed to the long continued action of a different climate

As a matter of fact, most of these changes are just what would be beneficial in a country having a hot, dry, summer with a relatively long winter If planted in a very moist place, the American elm develops some of the characteristics of the English elm

Woodruff[59] has pointed out one marked case of adaptation to climate

The shape and size of the nose and position of the nostrils are now fairly well proved to be a matter of selection of fittest variations In the tropics where the air is hot and therefore rarefied, more of it is necessary and it is essential that there should be no impediment to the air currents, so that the nostrils are open and wide and the nose very flat Such a nose is unsuited for cold countries, as it permits masses of cold air to flood the air passages and irritate the lining membrane, so that the nose must be large and have much warming surface, and the nostrils therefore are slender slits to admit the air in thin ribbons easily warmed The air being cold is concentrated, and less of it is needed than in the tropics and the slender nostril is no disadvantage. The nasal index or extreme width of nose divided by the extreme length, gradually increases as we go to colder countries, where we find some races with nose index much greater than one thousand, *i e*, width greater than length. It is now many years since it was first pointed out that the open tropical nostril was one reason for so much pulmonary trouble of negroes out of tropics. Hence there must have been a natural selection in cold countries of one kind of variations—large concentrated noses, and a selection in hot countries

[56] "The Survival of the Unlike," 319, 1898

[57] "Animals and Plants under Domestication," 2d ed., 2, 27, 1890

[58] [The italics are mine —W. D B]

[59] "Effects of Tropical Light on White Men," 4, 1905

of the other extreme, so that the various types gradually arose.

The great Biblical Pharaoh Rameses II had a prominent, slender nose not now found in any Egyptians, and it is a positive proof of the recent arrival of some ancestor from the north. He was like Lord Cromer—a northern type ruling a native type.

Allen[60] has called attention to a correlation between climate and the color of birds.

The increase in color towards the south coincides with the increase in the intensity of the sun's rays and in the humidity of the climate. The increase in color observed in birds on passing from east to west [in the United States] seems also to coincide with an increase of humidity, "the darker representatives of any species occurring where the annual rainfall is greatest, and the palest where it is least." This coincidence occurs not only in the birds of the United States to such a degree that Allen says he knows of no exception, but in Europe also. Thus birds from the Scandinavian coast are very much darker than in central Europe, where the rainfall is only half as great. Allen says that this correlation of brighter and deeper tint with increased humidity is exhibited by the mammals of these districts as well as by the birds.

NON-ADAPTABILITY

While the theorem of Le Chatelier enables us to account for the direction of a change, it does not tell us whether a given stimulus will actually produce a change or under what condition the change will be a maximum for the same stimulus. We can make a fair guess at the answer by studying ourselves. We know that, as we get older, our tendency to resist change increases; our habits of body and mind become more fixed. We should therefore be tempted to conclude that the resistance to change increases as the organism becomes mature and that a given stimulus would probably have the most effect if applied at or before the earliest stages of development. The following quotation from Vernon[61] would seem to indicate that this was often true.

Due reflection, will, I believe, incline one to infer that what is true for echinoid larvæ is true for most multicellular organisms. In fact, it would seem to be a law of general application that *the permanent effect of environment on the growth of a developing organism diminishes rapidly and regularly from the time of impregnation onwards.*

It is curious that this principle, enunciated by the author in 1900, should have been laid down by De Vries only a few months later, as the result of his observations on plants. Thus, judging from the effects of nutrition (manuring, planting out, good light and watering), he concluded that (1) the younger a plant is, so much the greater is the influence of external conditions on its variability. (2) The nutrition of the seed, when developing on the maternal plant, has—at least very often—a greater influence on the variability than nutrition during its germination and later growth.

If the pressure on a liquid is made less than the vapor pressure for that liquid at that temperature, some of the liquid vaporizes, the temperature falls, and the liquid may be said to adapt itself to the new conditions. What would happen if the liquid were not adaptable? The easiest way to obtain a non-adaptable liquid is to place a Bunsen burner under it. The temperature rises until the boiling-point is reached. The liquid then ceases to be adaptable. It volatilizes, it disappears, it becomes extinct so far as that particular region or flask is concerned. If a species can not adapt itself to changed climate or other conditions, it does not volatilize, but it disappears, it becomes extinct. It may be a new point of view to consider the extinction of the mastodon as analogous to the distillation of water; but the two cases are really parallel, except in time.

It should be kept in mind that non-adaptability is not the only cause for ex-

[60] Vernon, "Variations in Plants and Animals," 327, 1903.

[61] "Variation in Animals and Plants," 199, 1903.

tinction. A species might have enormous potential adaptability, but it would become extinct if the death-rate were too high in comparison with the rate of adaptation. This principle is made use of in the fight against weeds:[62]

Weeds, like other plants, grow where they can find room, and the more room any plant can find, other things being the same, the farther and more rapidly it will spread over the earth. But room, used in this connection, does not mean, entirely, space vacant of other plants, but rather conditions of competition into which the given plant can fit itself with prosperity. Ground may be covered with a given plant, and yet a species of wholly different character and habits may thrive along with it. This is well illustrated in the growth of twining or climbing vines in dense thickets of shrubbery, or the practise, common even with the Indians, of growing pumpkins in corn fields. If weeds, then, are to be kept out of grounds, the land must not only be occupied with some other crops, but with a crop which will not allow the weed to grow along with it. In practise, it is impossible to select all crops from plants which so completely encumber the ground that no intruder can find a foothold; but this disadvantage is readily and almost wholly overcome by means of the rotation of crops—one crop in the rotation destroying what weeds may have crept in with the preceding ones. Thorough cropping of the land and judicious rotation of crops, therefore, are conditions against which no weeds can stand; and as these are the vital conditions, also, of successful agriculture, it may be said that then lands are well farmed.

The daisy-cursed meadows of the east are those which have been long mown and are badly "run," or else those which were not properly made, and the grass obtained but a poor start. The farmer may say that the daisies have "run out" the grass, but the fact is that the meadow began to fail, and the daisies quickly seized upon the opportunity to gain a foothold; and just so long as the farmer persists in his accustomed methods will the daisies usurp the land. The weedy lawns are those which have a thin turf, and the best treatment is to scratch the ground lightly with an iron-toothed rake, apply fertilizer and sow more seed; in other words, augment the struggle for existence, and the weeds will go down before the June grass, and the grass plants themselves, because of the greater numbers, will be more slender and will make a softer turf.

[62] Cf. Bailey, "The Survival of the Unlike," 194, 198, 1896.

ATTITUDE OF BIOLOGISTS

It may be asked to what extent biologists make use of the theorem of Le Chatelier as a working hypothesis in studying the effect of external conditions. So far as I can learn, nobody makes any active use of it, and many biologists would deny the applicability of the theorem.

Darwin[63] began by attributing very little to the direct action of the climate, etc.; but later he stated that more weight should have been allowed to the direct action of the environment, *i. e.*, food, climate, etc., independently of natural selection. He says[64] that it is "probable that variability is directly or indirectly caused by changed conditions of life. Or, to put the case under another point of view, if it were possible to expose all the individuals of a species during many generations to absolutely uniform conditions of life, there would be no variability." In spite of this he states[65] explicitly that long-continued action of a different climate has produced differences in American trees which are of no especial service to them.

Nägeli's[66] "extensive cultural experiments with alpine *Hieracia* led him to form the opinion that the changes which are induced by an alteration in the food-supply, in climate or in habitat, are not inherited and are therefore of no importance from the point of view of the production of species."

[63] Cf. Schwalbe, "Darwin and Modern Science," 125, 1909.

[64] Darwin, "Animals and Plants under Domestication," 2d ed., 2, 242, 1890.

[65] Darwin, "Animals and Plants under Domestication," 2d ed., 2, 271, 1890.

[66] Cf. Klebs, "Darwin and Modern Science," 225, 1909.

De Vries[67] is distinctly not prepared to admit that mutations are described by the theorem of Le Chatelier.

The origin of new species, which is in part the effect of mutability, is, however, due mainly to natural selection. Mutability provides the new characters and new elementary species. Natural selection, on the other hand, decides what is to live and what to die. Mutability seems to be free, and not restricted to previously determined lines. Selection, however, may take place along the same main lines in the course of long geological epochs, thus directing the development of large branches of the animal and vegetable kingdom. In natural selection it is evident that nutrition and environment are the main factors. But it is probable that, while nutrition may be one of the main causes of mutability, environment may play the chief part in the decisions ascribed to natural selection. Relations to neighboring plants and to injurious or useful animals, have been considered the most important determining factors ever since the time when Darwin pointed out their prevailing influence.

There is nothing very definite to be obtained from Klebs.[68]

The dependence of *variable internal* on *variable external* condition gives us the key with which research may open the door. In the lower plants this dependence is at once apparent, each cell is directly subject to external influences. In the higher plants with their different organs, these influences were transmitted to cells in course of development along exceedingly complex lines. In the case of the growing point of a bud, which is capable of producing a complete plant, direct influences play a much less important part than those exerted through other organs, particularly through the roots and leaves, which are essential in nutrition. These correlations, as we may call them, are of the greatest importance as aids to an understanding of form production. When a bud is produced on a particular part of a plant, it undergoes internal modifications induced by the influence of other organs, the activity of which is governed by the environment, and as the result of this it develops along a certain direction; it may, for example, become a flower. The particular direction of development is determined before the rudiment is differentiated and is exerted so strongly that further development ensues without interruption, even though the external conditions vary considerably and exert a positively inimical influence: this produces the impression that development proceeds entirely independently of the outer world. The wide spread belief that such independence exists is very premature and at all events unproven.

The state of the young rudiment is the outcome of previous influences of the external world communicated through other organs. Experiments show that in certain cases, if the efficiency of roots and leaves as organs concerned with nutrition is interfered with, the production of flowers is affected, and their characters, which are normally very constant, undergo far-reaching modifications. To find the right moment at which to make the necessary alteration in the environment is indeed difficult and in many cases not yet possible. This is especially the case with fertilized eggs, which in a higher degree than buds have acquired, through parental influences, an apparently fixed internal organization, and this seems to have predetermined their development. It is, however, highly probable that it will be possible, by influencing the parents, to alter the internal organization and to switch off development on to other lines.

Bailey is quite clear that the environment has a marked effect upon plants, but he is very far from formulating that effect, as the following quotations will show.[69]

These differences [between individual plants] arise as a result of every impinging force, soil, weather, climate, food, training, conflict with fellows, the strain and stress of wind and wave, and insect visitors, as a complex resultant of many antecedent external forces, the effects of crossing, and also as the result of the accumulated force of mere growth; they are indefinite, non-designed, an expression of all the various influences to which the passive vegetable organism is or has been exposed; these differences which are most unlike their fellows or their parents find the places of least conflict and persist because they thrive best, and thereby impress themselves best upon their offspring.

It is not too much to ask of climatology that it shall tell us why the northern climates develop saccharine elements and high colors, and why the

[67] "Darwin and Modern Science," 77, 1909.

[68] "Darwin and Modern Science," 223, 236, 242, 1909.

[69] Bailey, "The Survival of the Unlike," 32, 309, 1896.

Wisconsin-Minnesota area produces such remarkable waxen and pruinose tints. The influence of the climate is nowhere so easily traced, perhaps, as in the business of seed growing. Every seedsman knows that certain climates are not only best adapted to growth of certain seed crops, but that they exert a profound influence upon the character of the product grown by them. The study of all these interrelations of climate and plant life falls into three subjects: phenology, or the study of the periodic phenomena of plants, a subject which loses half its value when considered, as it usually is, without reference to the visible attending features of climate; acclimatization, or a consideration of the means by which plants adapt themselves to climates at first injurious, and secondary variations of plants induced by climate environment.

The burden of my plea is twofold. First, while not discouraging the instrumental or conventional study of climate, I would encourage its study in terms of plant life. Second, it is essential that the synchronisms of local climate and the phenomena of plants be given the closest attention.

Sedgwick[70] is quite clear as to the direction of the changes, but I can not see that he makes any actual use of this as a working hypothesis.

It is a property of living matter to react in a remarkable way to external forces without undergoing destruction. The life-cycle, of which the embryonic and larval periods are a part, consists of the orderly interaction between the organism and its environment. The action of environment produces certain morphological changes in its organism. These changes enable the organism to come into what is practically a new environment, which in its turn produces further structural changes in the organism. These in turn enable, indeed necessitate, the organism to move again into a new environment, and so the process continues until the structural changes are of such a nature that the organism is unable to adapt itself to the environment in which it finds itself. The essential condition of success in this process is that the organism should always shift into the environment to which the new structure is suited—any failure in this leading to the impairment of the organism. In most cases the shifting of the environment is a very gradual process (whether consisting in the very slight and gradual alteration in the relation of the embryo as a whole to the egg-shell or uterine wall, or in the relations of its parts to each other, or in the successive phases of adult life), and the morphological changes in connection with each step of it are but slight. But in some cases jumps are made such as we find in the phenomena known as hatching, birth and metamorphosis. This property of reacting to the environment without undergoing destruction is, as has been stated, a fundamental property of organisms. It is impossible to conceive of any matter to which the term living could be applied being without it. And with this property of reacting to the environment goes the further property of undergoing a change which alters the relation of the organism to the old environment and places it in a new environment.

This quotation is not what we want, because Sedgwick is considering the life cycle of an individual, which is not our problem at all. It is good as far as it goes, however, and it is the best that I have been able to find.[71]

We get the opposite extreme with Bateson,[72] who says:

To those who have made no study of heredity it sometimes appears that the question of the effect of conditions in causing variation is one which we should immediately investigate, but a little thought will show that before any critical inquiry into such possibilities can be attempted, a knowledge of the working of heredity under conditions as far as possible uniform must be obtained.

The cap seems to fit and I am quite ready to put it on. Bateson's argument is simply that a change due to reversion might be interpreted as due to a change in environment. This is a possible source of error, but it is one which can be eliminated by making enough experiments and by making experiments with different species of plants. It is hardly conceivable that a reversion to an albino variety, for instance, should coincide with a given change of environment in every experiment and with every kind of plant. On the other hand,

[70] "Darwin and Modern Science," 177, 1909.

[71] Cf. also Bourne, Science, 32, 738, 1910.

[72] "Darwin and Modern Science," 95, 1909.

it is always a good plan to do the easiest things first, partly because it takes less time to get results, but chiefly because the easy things usually throw light on the hard ones. We know that suitable changes in the environment, if made at a suitable time, will cause such changes in the organism that the next generation differs from the first. It is a very difficult problem to determine the intermediate steps; but it is a relatively simple one to determine what change in the second generation is the result of a change in a single factor of the environment This is a problem which has not been attacked by the biologist in any systematic fashion, and it is a problem which will be greatly simplified by an intelligent application of the theorem of Le Chatelier.

The view of the biologists seems to be that each generation always varies spontaneously from the preceding one to a greater or lesser extent, and that these variations are reproduced more or less completely in the succeeding generation. By the survival of the fittest we eventually get a race which is better adapted to the local conditions than the one from which we started.

The view that I have outlined is that the external conditions tend to produce such changes in the organism that the next generation varies in such a way as to be more adapted to local conditions. By the survival of the fittest and by the continued action of the external conditions, we eventually get a race which is better adapted to the local conditions than the one from which we started

We reach the same conclusion whichever way we consider the matter. The two views are not mutually exclusive because it is quite possible to consider the variation due to the external conditions as superimposed on the spontaneous variations. If we are to decide between the two points of view, it must be on other grounds than qualitative results. To me, the phrase "spontaneous variation" seems merely another way of expressing our ignorance I do not believe in a variation without a cause If we go back far enough, all variations must be the result of varying external conditions and the real problem is to show what part of any given variation in any given organism is due to the effect of external conditions on the preceding generation and what part is due to the effect of external conditions on still earlier generations. What we study under heredity, as the word is usually used, is the transmitted effect of varying external conditions upon the more or less remote ancestors

Another objection to the biologist's point of view is that it has not worked out well practically Being obsessed by the idea of spontaneous variation, he has very rarely taken the trouble to work out carefully the relation between each particular factor of the external conditions and the acquired characteristics of the organism which has become better adapted to its surroundings If the biologist had had the theorem of Le Chatelier as a guiding hypothesis, he would not have made this mistake and he would often have done better and more careful work.

I have tried to show that the theorem of Le Chatelier is a universal law and that it is consequently of great value in enabling us to correlate old facts and to discover new ones

Wilder D. Bancroft
Cornell University

THE SEVENTEENTH INTERNATIONAL CONGRESS OF AMERICANISTS

The second session of the seventeenth International Congress of Americanists was held

in the Museo Nacional, Mexico City, Mexico, September 8–14, 1910.[1] In addition to Mexico, the following countries were represented by official delegates present. Austria-Hungary, China, Costa Rica, Cuba, France, Germany, Guatemala, Holland, Italy, Japan, Portugal, Salvador, Spain and the United States of America There were also in attendance delegates from a number of learned societies and other institutions from various parts of the world

The United States government was represented by Professor Franz Boas, Professor Roland B. Dixon, Dr Aleš Hrdlička and Dr Alfred M. Tozzer. The state of Louisiana was represented by Judge Joseph A Breaux Delegates from several American institutions were present Drs. Pliny E. Goddard and Herbert J Spinden, American Museum of Natural History, Mr. Stansbury Hagar, Brooklyn Institute of Arts and Sciences; Mr. William Beer, Howard Memorial Library; Mrs. Zelia Nuttall, University of California; Professor George B Gordon, University of Pennsylvania; and Dr. George Grant MacCurdy, Yale University. All these are members of the American Anthropological Association

To any one interested in American archeology Mexico offers remarkable attractions, not only in the priceless treasures of the Museo Nacional, but also in the number and grandeur of the prehistoric ruins The author spent five weeks in excursions to various sites, and in study at the museum. His program was no doubt duplicated by many other visiting members. The only official excursions announced by the committee of organization were those to Teotihuacan, Mitla and Xochicalco. The first of these took place during the congress To it were invited not only the members of the Americanist Congress but also the official delegates to the Mexican centenary, the hosts being the department of foreign affairs as well as that of public instruction and fine arts. It was made the occasion for the opening of the new museum at the ruins of Teotihuacan. An elaborate dinner was served in the celebrated grotto near the Pyramid of the Sun, at which speeches were made by both the secretary of foreign affairs, Señor Creel, and the secretary of public instruction and fine arts, Señor Sierra. The excursions to Mitla and Xochicalco took place after the congress and were unfortunately marred by some confusion and delay.

Among the centennial attractions that were of special interest to the Americanists was the great historic pageant occurring the day after the congress closed The first section of the pageant numbering 889 persons, dealt with the epoch of the conquest, particularly the first meeting between Montezuma and Cortes (1519). The sections which followed represented the epochs of Spanish dominion and of independence, respectively

There were a number of special social functions in honor of the congress, including receptions by the minister of public instruction and fine arts, and by Mrs Zelia Nuttall at her interesting home, Casa Alvarado, in the historic old suburb of Coyoacan.

The mode of selection of the council emphasized a weakness of the statutes that should be remedied by amendment at the next congress So far as I have been able to ascertain, no change has been made in the statutes since the close of the first congress[2] Article 7 of the statutes is as follows:

> The Assembly elects the Members of the Council of which the number is determined by the Committee of Organization.
>
> Each nationality should, at all events, be represented by at least one Member.

This article gives the committee of organization power to limit the number of the council and thus in a measure to determine its personnel. By its very nature the committee of organization is temporary and a local body; while the congress itself is international. Not a single member, for example, of the committee of organization of the immediately preceding congress in Vienna was on the com-

[1] A session had already been held in Buenos Aires during the month of May.

[2] Congrès intern. des Americanistes, Compte rendu de la première session, t. II., p. 170, Nancy, 1875.

mittee of organization of the congress in Mexico. The latter committee decided to limit the council to governmental delegates. In doing so it took into the council diplomats and the judge of a state court, excellent men all of them, but only momentarily interested in the purposes for which the congress exists At the same time it left out of the council those who have been attending the congresses for years, some of whom had previously sat in its councils, and including professional Americanists attached to and delegated by some of the foremost museums and institutions of learning in America. If the last paragraph of article 7 can be construed in such a manner as to take the control of the congress away from those, but for whom it could not exist, it should be amended at the first opportunity, and the power to limit the number of the council should be transferred from the ephemeral committee of organization, often composed of members who never attended a congress before and who will probably never do so again, to the "Assembly" of members present, which in a measure, at least, is a perpetual body

During the congress, a committee of delegates from Mexico, France, Germany, Harvard University, the University of Pennsylvania and Columbia University met and agreed upon the foundation of an international school of archeology in the city of Mexico. Other governments and universities may take part in this movement by subscribing to the by-laws (now in process of ratification). The present director of the school is Professor Eduard Seler.

The next congress will be held in London during the month of September, 1912.

The following papers were presented and will be published in the *Compte rendu* of the congress:

"La etnología de las razas indígenas que poblaron las comarcas del sur de Tamaulipas," Alejandro Prieto.

"Contribution to the Anthropology of Peru," Aleš Hrdlička.

"La huella más antigua quizá del hombre en la península de Yucatan; Estudio de la industria prehistórica de Concepción (Campeche)," Jorge Engerrand.

"Pruebas geológicas de que la parte norte de la peninsula yucateca no ha podido ser habitada por el hombre durante la época cuaternaria," Jorge Engerrand.

"Un caso de cruzamiento entre un Chino y una Yucateca de origen indígena," Jorge Engerrand.

"Quelques observations sur l'art de guerir chez certains tribus nomades du nord du Mexique," Theo. Dupoyet[1]

"La trepanacion entre nuestros aborígenes," Alberto M Carreño

"El rayo de luz y la cronología india," Abraham Castellanos

"Sobre correcciones del período de Venus en los manuscritos historicos mexicanos," Hermann Beyer[1]

"Zodiacal Symbolism of the Mexican and Maya Month- and Day-signs," Stansbury Hagar

"The Celestial Plan of Teotihuacán," Stansbury Hagar

"El zodiaco de los Incas en comparacion con el de los Aztecas," Arnolfo Krum Heller

"Los grandes ciclos de la historia maya según el manuscrito del Chumayel," Juan Martinez Hernandez

"La medicina entre los Indios mexicanos antes de la conquista," Francisco A. Flores.

"Publicaciones nuevas sobre la linguistica americana," Franz Boas.

"A Classification of Maya Verbs," Alfred M. Tozzer.

"Lenguas de la familia nahuatlana; su clasificacion," Francisco Belmar.

"Dios ¿Que idea tenian de el los antiguos mexicanos?" Cecilio A. Robelo[1]

"Idolatrias y supersticiones de los Indios," Vicente de P. Andrade.

"El verdadero concepto de la etnología: La ciencia de gobernar," Andres Molina Enríquez (read by title).

"Algunas lenguas que se hablan en el sur del Estado de Chiapas," Carlos Sapper.[1]

"The Language of the Tano Indians of New Mexico," John P. Harrington.[1]

"Colon y la lengua castellana y las americanas," Antonio Sánchez Moguel.

[1] Read by title, but will be published in the *Compte rendu* of the congress.

"Itinerario de la expedición de Hernán Cortés á Hibueras," Marcos E. Becerra[*]

"El testamento de Hernán Cortés," Francisco Fernández del Castillo

"Une mappe inédite de 1534, avec texte espagnol au verso," Louis Capitan

"L'œuvre géographique de Humboldt en Mexique," Eugen Oberhummer

"Les observations géographiques dans les lettres de Cortes," Eugen Oberhummer[*]

"Resumen de mis estudios de documentos del siglo XV contenidos en el Archivo General y Público de la Nacion," Zelia Nuttall.

"Algunos de los primeros establecimientos de instrucción en el Reino de Nueva Galicia," Francisco Escudero[*]

"Estudio geografico, historico, etnografico y arqueologico de la Republica de El Salvador," Leopoldo A. Rodríguez

"Breves notas sobre la historia, la arqueología y la etnogenia del territorio de Tepic," Francisco A. Flores

"Notes sur le Mexique," Auguste Genin.[*]

"A Manuscript in Washington," Charles Warren Currier[*]

"El Votan," Enrique Santibanez

"Photographic Notes on the Pueblo Indians of Southwestern United States," Frederick I. Monsen[*]

"Estudio sobre la teoria del origen oriental de algunas razas americanas," Manuel Cortes[*]

"Chronological Sequence of the Sculptures of Copan," Herbert J. Spinden

"Sobre algunas representaciones del dios Huitzilopochtli," Hermann Beyer[*]

"Une figuration de Quetzalcoatl sous forme de serpent emplumé enroulé, provenant de Mexico," Louis Capitan

"La stylisation de la figure humaine et la représentation des sacrifices humains sur les vases peints preincasiques de Vazca (Pérou)," Louis Capitan

"Miniature Clay Temples of Ancient Mexico," H. Newell Wardle

"An Aztec 'Calendar Stone' in the Yale University Museum," George Grant MacCurdy

"Elements of Kato, an Athabascan Dialect," Pliny E. Goddard.

"Las ruinas de Uxmal," Eduardo Seler

[*] Read by title, but will be published in the *Compte rendu* of the congress.

"The Ruins of Northeastern Guatemala," Alfred M. Tozzer

"Un dato sobre la evolución del alfabeto entre los azteca y los maya," Jesús Díaz de León

"La reparacion de las ruinas de Xochicalco," Leopoldo Batres

"Estudio comparativo de dos documentos historicos," Antonio García Cubas[*]

"Some Points in Louisiana Cartography," William Beer

"Three Centuries of Total Eclipses of the Sun in Mexico. 1850–2150," David Todd[*]

"Central and South America—Governmental Cooperation the Key to Great Opportunity," Louis E. Walkins[*]

"Résumé of the Papers, read at the Sixteenth Congress held at Vienna, on Mexican History, Architecture, Art, etc." Franz Heger.

GEORGE GRANT MACCURDY

YALE UNIVERSITY,
NEW HAVEN, CONN.

THE NEW PLAN FOR ADMISSION TO HARVARD UNIVERSITY

ON January 17 the Faculty of Arts and Sciences of Harvard University voted to adopt the plan of admission as given below as an alternative to the system at present in force. The plan, it will be noted, is a compromise between the certificate and examination methods. It is intended to obviate "cramming" for examinations and to improve articulation with secondary schools, especially public high schools.

A. Evidence of the completion of an approved secondary school course.

1. Tabulated statement. A candidate shall present to the committee appointed to administer this plan evidence as to his secondary school work in the form of an official detailed statement showing (*a*) The subjects studied by him and the ground covered. (*b*) The amount of time devoted to each. (*c*) The quality of his work in each subject.

2. Approved school course. An "approved secondary school course" must (*a*) extend over four years, (*b*) concern itself chiefly with languages, science, mathematics and history. No one of these four subjects may be omitted. At least two studies of a candidate's school program must be carried to the stage required by the present advanced examinations of Harvard College, or by

the equivalent examinations of the College Entrance Examination Board

B. Examination in four subjects

1 Subjects. A candidate who presents evidence that he has satisfactorily completed an "approved secondary school course," shall offer himself for examination in the four subjects named below. A satisfactory record in these examinations shall admit to Harvard College without conditions (a) English, (b) Latin, or for candidates for the degree of S.B., French or German, (c) Mathematics, or Science (Physics or Chemistry), (d) any subject (not already selected under (b) or (c) from the following list. Greek, French, German, History, Mathematics, Chemistry, Physics

2 The examination papers (a) The preparation presupposed by the examination papers in the several subjects shall not be less than is ordinarily necessary for the present elementary examinations The papers shall contain a sufficient number of alternative questions, and shall be so framed as to permit variety in the methods of school instruction They shall also include advanced questions, thus permitting each student to reveal the full amount and the quality of his attainment. In any subject offered for examination which the candidate has pursued to an advanced grade he must present evidence of that grade of attainment The papers shall not, however, presuppose a greater length of preparation than is ordinarily required for the present Harvard examinations (b) Time of examinations. The four examinations must be taken at one time, in either June or September (c) Judging the examination books A copy of the candidate's school record shall be given to the readers of the examinations In judging the books the examiner shall submit a full statement of his opinion of each book. In addition, at the option of the examiner, a grade may be given

3. A satisfactory record. A "satisfactory record" shall not be construed to require that a candidate attain distinction in all four subjects, but shall mean that in the judgment of the Committee on Admission the candidate's examination record as a whole, when viewed as the basis for a general estimate of his quality, is such as to make his admission to Harvard College advisable

THE NEW YORK ZOOLOGICAL SOCIETY

THE seventeenth annual meeting of the New York Zoological Society was held at the Hotel Waldorf-Astoria, January 10, 1911, at 8 30 o'clock P.M. Mr. Henry Fairfield Osborn, president of the society, presided and Mr. Madison Grant, the chairman of the executive committee, laid before the meeting the report of that committee for the year 1910. Colonel C. J Jones gave the first public exhibition of a series of moving pictures showing the roping and capture of living wild animals in British East Africa, including lions, rhinoceroses and various antelopes, and Mr. Roy C. Andrews showed a series of pictures taken during the past season of the capture of whales in Japanese waters.

The report of the executive committee covered the following matters

During the year $12,848 have been expended for the purchase of animals, chiefly for the purpose of strengthening the collections in general, from a zoological point of view, rather than for the purchase of costly special features As a result of this policy, the collections, as a whole, are to-day stronger in rare species, and also in number of individuals, than at any previous period. The health of the collections at the park and the aquarium has been maintained at a high standard throughout the year, and there have been few losses of importance

Administration Building.—The administration building was completed and thrown open to the use of the members on November 20, 1910. It provides accommodations for the members of the society, and it is hoped that members and their guests will make full use of the opportunities afforded.

New Buildings.—The following new structures are under way at the present time: Ten additional bear dens and cages, eagles and vultures aviary, and a winter house for tropical birds of prey. Plans for a zebra house have been completed, and the contract, it is hoped, will be awarded during the winter.

National Collection of Heads and Horns.—The National Collection of Heads and Horns has been greatly increased during the year and now contains 688 specimens A few of the most notable additions are: Head of square-mouthed rhinoceros from Col. Theodore Roosevelt; bongo, from Mr. James L. Clark; New Brunswick moose, from Mr

Edwin C. Kent, and the following heads from Mr. H. Casimir de Rham: Karelin sheep, Turkestan sheep, Astor markhor, two Himalayan ibex, Quchim buffalo, Newfoundland caribou, musk ox and sable antelope.

Library.—The administration building will also contain the library, which now numbers 1,378 volumes. A fund of $2,000 was provided by two of the friends of the society for this purpose.

Gifts.—Among the most notable gifts have been a remarkable series of arctic animals from Mr. Paul J. Rainey, as follows: Six musk ox, two walrus, two polar bears, one blue fox.

Pheasant Expedition.—The New York Zoological Society expedition for pheasants is now in Siam, and is expected to return to New York some time during the summer of 1911. The expedition has been successful in securing specimens, living and dead, of nearly all the pheasants in the districts visited.

Aquarium.—The New York Aquarium has, in its present building, nearly reached the limit of its capacity both for its collections and for visitors. The enormous attendance makes it necessary to provide a larger and more modern building, and several studies of plans for this purpose have been made. The city will be asked to provide the necessary funds for the new aquarium.

SCIENTIFIC NOTES AND NEWS

SIR FRANCIS GALTON, eminent for his contributions to geography, meteorology, biology, anthropology and psychology, died on January 18, at the age of eighty-eight years.

AT the annual meeting of the trustees of the Carnegie Institution of Washington, Dr. Simon Flexner, of the Rockefeller Institute of Medical Research, Mr. Robert S. Brookings, of St. Louis, and Dr. Henry Pickering Walcott, of Boston, were elected to membership in the board.

SIR JOHN MURRAY will give a memorial address on "The Life and Scientific Works of Alexander Agassiz," at Sanders Theater, Harvard University, on Tuesday evening, February 14.

THE next Faraday lecture of the Chemical Society of London is to be given on June 14 by Professor Theodore W. Richards, of Harvard University, in Faraday's lecture-room at the Royal Institution on Albemarle Street, London.

DR. JACQUES LOEB, of the Rockefeller Institute for Medical Research, has been elected an associate of the Royal Academy of Science at Belgium, in the section of natural science; and also an honorary foreign member of the Academy of Medicine of Belgium.

DR. ALEŠ HRDLIČKA has been made a corresponding member of the Academy of Sciences, Prague.

SIR DAVID GILL has been elected a foreign member of the Swedish Royal Academy of Sciences, Stockholm.

M. EDOUARD BRANLY has been elected a member of the Paris Academy of Sciences in the section of chemistry. He received thirty votes, twenty-eight votes being cast for Madame Curie.

DR. DAVID FERRIER, F.R.S., emeritus professor of neuropathology in King's College, London, has been knighted.

PROFESSOR M. E. COOLEY, dean of the department of engineering of the University of Michigan, was given the degree of doctor of engineering by the University of Nebraska on January 18.

THE Geological Society of London will this year award its medals and funds as follows: The Wollaston Medal to Professor Waldemar C. Brögger, Sc.D.; the Murchison Medal to Mr. Richard H. Tiddeman, M.A.; the Lyell Medal to Dr. Francis A. Bather, M.A., and Dr. Arthur W. Rowe; the Bigsby Medal to Dr. O. Abel; the Wollaston Fund to Professor O. T. Jones, M.A.; the Murchison Fund to Mr. Edgar S. Cobbold; the Lyell Fund to Professor Charles G. Cullis, D.Sc., and Mr. John F. N. Green.

ADDITIONAL grants have been made to Professor T. W. Richards and to Professor G. P. Baxter, of Harvard University, of $2,500 and

$1,000, respectively, as research associates of the Carnegie Institution of Washington.

DR. G. CARL HUBER, professor of histology and embryology in the department of medicine of the University of Michigan, has tendered his resignation as secretary. Dr Huber has been made head of the new department of embryology at the Wistar Institute of Anatomy, Philadelphia, and will spend part of his time there An arrangement has been effected for the next two years By long service Dr. Huber has earned a year's leave of absence, which the regents have consented to allow in two periods of six months each. During the next semester Dr. Huber will be at the Wistar Institute, and he will return to the University of Michigan for the first semester of next year Dr C W Edmunds, professor of therapeutics and materia medica, has been elected secretary of the department

PROFESSOR R. A HARPER, head of the department of botany at the University of Wisconsin, has left for the University of California, where he will lecture during the remainder of the present academic year. Professor George J. Pierce, of Stanford University, will be acting professor of botany at the University of Wisconsin.

DR. ARTHUR W. WEYSSE, professor of biology at Boston University, has started on a trip around the world on sabbatical leave of absence. He will sail from San Francisco on February 8, for Hawaii and Japan, and will be away about eight months.

ON January 20 Professor Arthur Michael lectured before the members and research students at the department of chemistry at Clark University on his recent observations in connection with reversible organic chemistry. A result of the greatest importance is Professor Michael's discovery of an apparently new factor influencing the velocity of organic reactions.

DR. GEORGE T. MOORE, of the Shaw Botanical Gardens at St. Louis, gave a public lecture before the Society of Sigma Xi, of Cornell University, on January 17, on "Some Striking Advances in Botanical Science and the Application of these in Practical Affairs."

ON January 18 Professor A E. Kennelly, of Harvard University, delivered a lecture before the Society of Sigma Xi at the University of Pennsylvania on "Wireless Telegraphy and Telephony as compared with Wire Telegraphy and Telephony."

A SPECIAL meeting of the Geological Conference was held at Harvard University on January 31, when Mr. Frank A Perret, of Naples, Italy, spoke on "Volcanoes and Volcanic Action," with illustrations Mr. Perret has spent the last six years in the study of volcanic problems, and has lived on Vesuvius, Etna and Stromboli during their recent eruptions

AT a general meeting of the Association of Public School Science Masters held in London on January 11 and 12, the president, Sir Edwin Ray Lankester delivered an address on "Compulsory Science *versus* Compulsory Greek"

AT a meeting of the Royal Geographical Society on January 16 Dr Johan Hjort gave a detailed account of the Michael Sars North Atlantic deep sea expedition of 1910, which he, with Professor H. H. Grau, Dr. Helland-Hansen, Mr. E Koefoed, and Captain Thor Iversen, undertook at the suggestion and at the expense of Sir John Murray, who himself accompanied them.

UNIVERSITY AND EDUCATIONAL NEWS

THE General Education Board has made conditional appropriations as follows: Brown University, $100,000; Carleton College, $100,000; Colorado College, $50,000; Dakota Wesleyan University, $50,000; Denison University, $75,000; Fisk University, $60,000; Mount Holyoke College, $100,000; Randolph-Macon College, $50,000; Swarthmore College, $75,000, Wesleyan College for Women, $50,000.

THE bill increasing the annual appropriation from the state of Vermont to Middlebury College by $7,600 has been signed by Governor Mead. This will make the state appropriation to Middlebury $16,000 a year, beginning on July 1. The increase is "to provide additional instruction in the departments

of pedagogy, in forestry and in scientific branches related to the industries of Vermont."

A GIFT of $50,000 to Cornell University by Mrs Florence O. R. Lang, of Montclair, N J., will be used in the construction of a new building to house the shops of the Sibley College of Mechanical Engineering.

THE will of Octavia Williams Bates, of Baltimore, leaves to the library of the department of law of the University of Michigan, a bequest of $20,000 A bequest of $5,000 is made to the Detroit High School Scholarship Fund Association, an organization designed to lend money to graduates of the Central High School of Detroit, so that they may attend the university A number of other legacies for private and public purposes are provided. When all these are settled, the remainder of the estate is to go to the University of Michigan Miss Bates was a graduate of the literary department of the university in 1877, and of the law in 1896

DR. A M HILTEBEITEL has been appointed instructor in mathematics at the University of Pennsylvania. Dr H. B. Smith has been appointed instructor in the same department for the ensuing term, to fill the vacancy caused by the temporary absence of Professor Evans

AT the Massachusetts Agricultural College Dr. Guy Chester Crampton has been appointed associate professor of entomology. Dr. Crampton is a native of Alabama. He graduated from Princeton in 1904, took two years of graduate work at Cornell University, receiving his M A there in 1905, followed by two years at the universities of Freiburg, Munich and Berlin, where he received his Ph.D in 1908. He was an instructor in biology at Princeton from 1908 to 1910 and since the summer of 1910 has been professor of zoology at Clemson College.

DISCUSSION AND CORRESPONDENCE

NUMERICAL NOMENCLATURE

THE recent proposal of Professor James G. Needham[1] to use numbers and symbols as aids in zoological nomenclature, which has been sympathetically discussed by Professor Henry B. Ward[2] and destructively criticised by Professor T. D. A Cockerell[3] in the columns of SCIENCE, has reminded me that one of the earliest attempts at entomological classification employed the numerical method which Professor Needham appears to think likely to prove useful In the year 1766 (one hundred and forty-five years ago) the Rev. Jacob Christian Schaeffer, D D, began the publication of an illustrated work upon the insects found in the vicinity of Regensburg, his home, and brought it to a conclusion in the year 1779 The title of the work is given in Latin and German as follows· "Icones Insectorum circa Ratisbonam indigenorum coloribus naturam referentibus expressæ Natürlich ausgemahlte Abbildungen Regensburgischen Insecten" The indices of the several volumes show that they might have served as models for Professor Needham. Opening at random I find the following in volume I.:

	No
CICINDELA,	1
	2
	3
	4
	5
SPHINX.	
	No
Fam I Al angul	1
	2
	3
	4
	5
	6
Fam II Al. int caud. simpl.	1
	2
	3
	4
	5
	6
	7
	8
	9
	10
	11
Fam. III. Al int. caud pil	1
	2

[1] SCIENCE, N S, Vol XXXII, p. 295

[2] SCIENCE, N S, Vol. XXXIII, p. 25.

[3] SCIENCE, N S, Vol. XXXII., p. 428.

In volume III. we find *Hesperia malvæ* Linn. designated as the "Siebender sechsfüssiger Tagfalter mit schiefen Flugeln," etc.

"Verily, there is nothing new under the sun!"

For my part, I sympathize with all attempts to secure a fixed and simple system of nomenclature, but to revert to what were the methods of good old Dr. Jacob Christian Schaeffer in this twentieth century is not, in my opinion, the correct solution of our difficulties

The troubles of the student of nomenclature are not, I suspect, as great as they appear to be to those who do not possess the necessary apparatus of books and who have devoted more time to questions of morphology than to questions of taxonomy. I have not at present the leisure to take up the questions involved in this discussion as I should like to do, but simply wish to remind the readers of SCIENCE that the method of numerical designations was employed nearly a century and a half ago for an extensive fauna, and that the numbers for a good many species in various genera are therefore already "preoccupied"

W. J. HOLLAND

SCIENTIFIC BOOKS

Respiratory Calorimeters for Studying the Respiratory Exchange and Energy Transformations of Man By FRANCIS G. BENEDICT and THORNE M. CARPENTER Published by the Carnegie Institution of Washington. 1910. Pp. 210.

This contains a full description of the latest models of respiratory calorimeters. Two are mentioned, the "chair calorimeter" designed for individuals for six- to eight-hour periods during which they can remain comfortably seated in a chair, and the "bed calorimeter" for use at night or for the sick or bed-ridden.

The measurements of heat eliminated by man as made by this apparatus are based upon the fact that the subject is enclosed in a heat-proof chamber through which a current of cold water is constantly passing. The amount of water is carefully weighed. The temperatures of the water entering and leaving the chamber are accurately recorded at frequent intervals The walls of the chamber are held adiabatic, thus preventing a gain or loss of heat. Thermo-electric couples connected with a galvanometer notify an observer of temperature changes of the walls. The observer then corrects this by arbitrarily cooling or heating the outer metal walls, a second cold water current accomplishing the former and electric wiring the latter, both systems being outside the inner chamber The heat given to the first described water current circulating within the inner chamber, is exactly equal to the heat eliminated by radiation and conduction by the subject To determine the total heat elimination, the latent heat of water vapor evaporated from the skin and lungs must also be added The sensitiveness of this apparatus is very great. Foreigners as well as fellow countrymen have pronounced it a wonderful machine. In addition to the determination of heat elimination, the carbonic acid outgo and oxygen ingo are determined through an accessory apparatus which provides for the analysis of the circulating air

The apparatus is costly in the first instance and requires many workers to control In the hands of Dr. Benedict it has received notable improvements, and it is both wise and fortunate that he has had the splendid generosity of the Carnegie Institution to support his undertaking

GRAHAM LUSK

The Metabolism and Energy Transformations of Healthy Man during Rest By FRANCIS G BENEDICT and THORNE M. CARPENTER. Published by the Carnegie Institution of Washington. 1910. Pp. 255.

This work contains a very valuable compilation of statistics obtained from observation on many normal men who had been occupants of the respiration-calorimeter of Atwater, Rosa and Benedict As a rule records of the protein metabolism are not recorded, which leaves an important gap unfilled The authors state that the work of Zuntz and others who used respiration apparatus of the Zuntz type is "as accurate as can be expected with apparatus of this type." The recently published work of Durig, how-

ever, shows that the results of oxygen absorption and carbondioxide elimination as determined by the Benedict calorimeter and the Zuntz apparatus are identical. There is therefore no doubt that the preeminent feature of the apparatus used by Benedict is the calorimetric determinations.

The authors find that the average heat production for fifty-five subjects during waking hours is 97.1 total calories, 1.52 per kilogram of body weight, and 49.2 per square meter of body surface, per hour. These records are 35 per cent above the requirements in sleep. Further experiments showed an average requirement of 17.8 additional calories when a subject undressed, weighed himself and dressed again. An important generalization is that the pulse rate is more or less parallel to the total metabolism.

This book suffers very greatly from a fault that has pervaded the publications of the Nutrition Laboratory, both at Boston and at Middletown, and that is that the new discoveries are not sharply defined as separate from well-known facts. This fault occurs in Benedict's splendid monograph on "Inanition" where the one new fact, the quantitative determination of the amount of glycogen oxidized on the first and second days of fasting is passed over without emphasis.

The authors make the following statement: "A striking series of experiments has demonstrated very clearly that a change from a diet poor in carbohydrates to one rich in carbohydrates is accompanied by a considerable retention of water by the tissues of the body." This however is not an original observation, having been noted by Bischoff and Voit, fifty years ago.

The world owes a great debt to the work of the Carnegie Nutrition Laboratory and its forerunner in Middletown, which no one can gainsay. Criticism is offered in the spirit of Pflüger who held it to be the mainspring of every advance and the Altmeister adds, "deshalb übe ich es."

GRAHAM LUSK

The Elements of the Theory of Algebraic Numbers. By L. B. REID. New York, The Macmillan Company. 1910. Pp. xix + 454.

The title of this book is misleading, as it treats of no algebraic numbers other than quadratic; it can not be said to present even the elements of the theory of algebraic numbers. The author devotes 150 pages to the elementary congruencial properties of rational numbers and 300 pages to quadratic numbers. In view of the intimate relations between quadratic forms and the numbers and ideals of a quadratic field, the omission of an account of quadratic forms is certainly a serious defect in a book having the aims of the present one.

In a review of a book of the character of the present text, one has only to discuss questions of pedagogy. The author desires to bring out a closer relation between rational numbers and quadratic numbers. This he accomplishes by complicating the elements of rational numbers with the unnecessary machinery of quadratic numbers! We find on page 91 Wilson's theorem stated in the form

$$r_1 r_2 \cdots r_k + 1 \equiv 0 \pmod{p}, \quad k = \phi(p),$$

where $r_1, \cdots, r_k$ form a complete set of residues modulo p, a prime. A similar unnecessary complication is met on page 105. Positive and negative primes p are used, so that one must face $\phi(p) = |p| - 1$.

On page 247 the "introduction of the ideal" should read introduction of ideals. After stating formally theorem A and devoting fifteen lines to its proof, the author informs us that the "theorem therefore fails." Similarly, on pages 250–251, theorems are formally stated and later shown "not to hold in general." This peculiar style of pedagogy is decidedly a novelty to the reviewer. It may at least serve to put the reader on his guard as to the fallibility of "what is written in the book." In the present instance the reader may be prepared for the actual error in the theory as presented on page 316, where the author makes a general theorem depend upon an equation which he has earlier proved only for a few special cases. His single reference is to the case of Gauss's field of complex

integers ϕ-ϕi. Several errors appear on page 275; in the line below (2) and that above (3), m must be replaced by m_1; while the use of $\mathfrak{p}_1, \mathfrak{p}_2$ for δ_1, δ_2 is merely an oversight. At the bottom of page 255 the author speaks of introducing ideals into a number field.

Many of the proofs employed by the author in his case of quadratic fields are mere substitutions of 2 for n in the standard proofs on algebraic fields of degree n. In one place he says: "This proof could have been somewhat simplified had greater use been made of the fact that the realm under consideration was quadratic, but it seemed desirable to give the proof in a form at once extendable to realms of any degree." The reference is to his three-page proof that every quadratic field has a basis! Now the real justification of a special treatment of the quadratic field lies in the fact that particularly simple proofs may be given and the reader made acquainted with an important example without the algebraic difficulties inherent in the general field. The above remarks will serve to show how the author has filled 300 pages with properties of quadratic number, without entering upon a discussion of the class number, characters, genera and other important topics on quadratic numbers.

In the matter of references the author has been particularly unfortunate. In a book barely entering upon the threshold of the theory, a scarcity of references would have been entirely justifiable. But to give hundreds of references to a certain report on the subject (excellent although it be) and to completely ignore the literature and not even mention the names of the discoverers of the theorems is against all scientific traditions.

L. E. DICKSON

SPECIAL ARTICLES

THE RELATION OF COLLOIDAL SILICA TO CERTAIN IMPERMEABLE SOILS

THE interpretation of recent soil bacteriological studies upon the Truckee-Carson Irrigation Project at Fallon, Nev., is in many cases difficult because of the impermeability to irrigation water on certain shortly defined areas. These impermeable areas support practically no crop growth, although the soil is very similar to that of the good areas in appearance and soluble salt content. During the past two years it has been my belief, based upon rough estimations of the silica that could be washed out from samples of soil from good and poor spots upon the United States Experimental Farm at Fallon, Nev., that at least in some instances the permeability and impermeability bore some relation to the occurrence of silica in a colloidal condition. Certain peculiarities of the behavior of soil samples from good and poor spots toward colloidal silica have been noted in the laboratory. These facts are only indirectly connected with our soil bacteriological studies and seem of themselves of sufficient interest to warrant publication at this time.

The following is a brief summary of laboratory results which seem to confirm the theory that in certain soils impermeability is associated with the occurrence of colloidal silica.

One-gram samples of good soil shaken in ten cubic centimeters of carefully dialyzed colloidal silicic acid of specific gravity of 1.0108 coagulates in from three to eight hours at 28° C.

One-gram samples of bad soil similarly treated not only do not coagulate the silica but hold it in a colloidal condition even after the check tube of pure silicic acid has coagulated.

The mixing of small quantities of calcium chloride, calcium sulphate or dilute acids with samples of bad soil before their addition to the silicic acid enables them to coagulate the tube of colloidal silicic acid in as short a time as that necessary for samples of good soil.

The treatment of samples of bad soil with calcium chloride, calcium sulphate, or dilute acids destroys their impermeable character, in some cases enabling water to percolate through them as rapidly as in the case of good soils.

In these experiments it has been found that the two essentials are, first, a high degree of purity of the colloidal silicic acid; and,

second, the preparation of the colloidal silicic acid at such a concentration that in its pure condition it will remain uncoagulated for about ten days. If the preparation is much more dilute than this it may fail to coagulate even with the good soils, while if it is much more concentrated it coagulates, presumably from mechanical reasons, almost instantly upon adding soil samples from either good or poor spots.

Whether these results may have a practical bearing upon the management of the refractory soils in question can be determined only by rather extensive field experiments. It is believed, however, that the action of calcium sulphate (gypsum) will improve these soils in the field as it has in the laboratory and that the crop-producing power of the poor areas may then approach that of the good areas.

KARL F. KELLERMAN
BUREAU OF PLANT INDUSTRY,
WASHINGTON, D. C.

THE BOTANICAL SOCIETY OF AMERICA

THE annual meeting of the Botanical Society of America was held at the University of Minnesota, Minneapolis, Minn., December 27 to 30, 1910. The officers for 1911 are:

President—W. G. Farlow, Harvard University.

Vice-president—A. W. Evans, Yale University.

Treasurer—Arthur Hollick, New York Botanical Garden.

Secretary—Geo. T. Moore, Missouri Botanical Garden.

Councilors—F. E. Clements, University of Minnesota, C. L. Shear, Bureau Plant Industry; R. A. Harper, University of Wisconsin.

The following associate members were elected to full membership: O. W. Caldwell, University of Chicago; E. W. Olive, South Dakota College of Agriculture, R. H. Pond, Texas Agricultural Experiment Station, A. D. Selby, Ohio Experiment Station, M. B. Thomas, Wabash College; and the following botanists were elected to associate membership: Harley Harris Bartlett, Bureau of Plant Industry; Frederick K. Butters, University of Minnesota, H. L. Bolley, North Dakota Agricultural College; Merritt Lyndon Fernald, Gray Herbarium; Douglas Houghton Campbell, Stanford University; William Crocker, University of Chicago; Abel Joel Grout, Curtis High School, New York City, Hans Th. Guessow, Dominion Botanist, Ottawa, Canada; Frederick De Forest Heald, University of Texas; E. C. Johnson, U. S. Department of Agriculture, Frank D. Kern, Purdue University, C. H. Kauffman, University of Michigan, Ivey Foreman Lewis, Randolph-Macon College, Emile P. Mienecke, Bureau Plant Industry, Raymond J. Pool, University of Nebraska; Chas. V. Piper, U. S. Department of Agriculture, Leigh H. Pennington, Syracuse University, Carl Otto Rosendahl, University of Minnesota; Paul C. Standley, National Museum, Fred J. Seaver, New York Botanical Garden, Josephine E. Tilden, University of Minnesota, Chas. Edw. Amory Winslow, College of City of New York, Herbert Hice Whetzel, Cornell University; E. Mead Wilcox, University of Nebraska.

The symposium on "Some Aspects of Plant Pathology" was held at the Agricultural College on Thursday and participated in by Professor L. R. Jones, who spoke on "The Relation of Plant Pathology to Other Sciences", Professor B. M. Duggar, who spoke on "Physiological Plant Pathology," and Professor E. M. Freeman, who spoke on "Resistance and Immunity in Plant Diseases." These papers, with the discussions, will be published and reprints distributed to the members of the society.

At the close of the dinner for botanists, the conference on botanical teaching was held, in which Professor C. E. Bessey, O. W. Caldwell, F. E. Clements, J. M. Coulter, R. A. Harper and F. C. Newcombe participated. This discussion will likewise be published and distributed to the members.

Following are abstracts of the papers presented at the scientific sessions held on Wednesday and Friday afternoon.

Light as a Formative Factor in the Habit of Growth of Asparagus plumosus: FREDERICK C. NEWCOMBE, University of Michigan.

The shoots of this house plant grow erect for a time, and then turn their tips to the horizontal position. Although this horizontal bend is geotropic, as shown by the klinostat, the process of bending is profoundly influenced by the presence of light. The new shoots which start up from subterranean buds are indefinitely nourished in the dark by the older shoots left in the light.

If a new shoot, a day before the bend was to be made, were covered by an opaque inverted cone of paper, the horizontal bend would occur without noticeable change from the normal. If the light were excluded two days before the time for the

bending, the time of bending would be delayed. Still greater delay in bending would follow an earlier covering.

If, now, a subterranean bud which has started to unfold be covered and caused to grow without ever being in the light, the period of erect growth will be greatly prolonged, the horizontal bend will never be complete, but, instead, there will be nutations up and down through an arc of usually 20° to 50°, these nutations lasting indefinitely.

This behavior may fall under one of two hypotheses: (1) etiolation disarranges the normal processes; (2) there is a weak inheritance of diageotropism which needs the supporting influence of light induction to give the usual form to the plant.

The Relation of Transpiration to the Water-content of Leaves in the Ocotillo: FRANCIS E. LLOYD, Alabama Polytechnic Institute.

During the summer of 1910 at the Desert Botanical Laboratory comparative volumetric and gravimetric data were obtained for transpiration in the ocotillo (*Fouquieria splendens*) during a period of twenty-four hours. The moisture-content of the leaves of this plant was also determined for a similar period on two occasions. The behavior of the stomata was determined by the measurement of 300 for each of six hours during the twenty-four. The following conclusions are drawn.

Comparative volumetric and gravimetric data show that, in the ocotillo, the ratio between the intake and outgo of water is not a constant, but that, aside from changes of secondary nature, the outgo is greater during the day than the intake. The reverse relation obtains during the night.

The amount of water relative to the dry weight of the leaves decreases till some time in the earlier part of the afternoon. After this time it increases till about four A.M.

This change in water content of the leaf explains at least in part the discrepancy between the income and outgo of water.

The decrease of water in the leaf occurs during the period of opening of the stomata. These organs are therefore not closely regulatory of the rate of transpiration.

Relation of Certain Fungi to Nitrogen Fixation: B. M. DUGGAR and LEWIS KNUDSON, Cornell University.

As a result of comparatively recent investigations in Europe and America it has been reported that many fungi growing in solution cultures have a power of "fixing" atmospheric nitrogen.

It has seemed necessary to determine by more extensive experiments the amount of this fixation by fungi from diverse habitats grown under a variety of conditions. The following fungi were employed in two series of experiments involving about 400 flask cultures: *Coprinus comatus*, *Dædalia Quercina*, *Polyporus sulphureus*, *Trichoderma lignicola* and *Aspergillus niger*.

The culture media employed consisted of (1) a nutrient salt solution, such as used by other investigators, to which was added, in some cases, known amounts of combined nitrogen, and variable quantities of sugar, (2) filter paper moistened with preceding solutions; (3) quartz or graphite moistened with nutrient solutions, decoctions of mangel-wurzels, (5) dead leaves which were dried, powdered and moistened, (6) dried leaves, as in the preceding, with varying quantities of sugar; (7) decayed leaves or leaf mould, (8) leaf mould with varying quantities of sugar, and (9) leaf mould well aerated by including with it balls of filter paper. The nitrogen determinations indicate that there is no fixation of atmospheric nitrogen except possibly in certain cultures of *Aspergillus niger*. In many cases there is a nitrogen loss which is to be accounted for, usually, by the production of N_2.

In a third series of experiments additional fungi have been tested, and the experiments of other investigators duplicated. In the light of the results reported general indications were given respecting the possibility of nitrogen fixation by this group of organisms.

Cryptomeric Inheritance in Onagra: C. STUART GAGER, The Brooklyn Botanic Garden.

Reference was made to an abnormal plant of *Onagra biennis* that appeared in a pedigreed culture following exposure to radium rays of the ovule employed in producing the plant. The plant possessed two primary shoot-systems (rosettes and subsequent cauline stems) of equivalent value, but manifesting entirely unlike morphological characters. Photographs were shown, and various possibilities were suggested as to the cause or causes of the anomaly. That the effect was due to the exposure to radium rays was held to be possible, though not conclusively shown. The antecedent history of the plant, and the fact that hybrids between the two unlike halves manifested, in the F_1 and F_2 generations, the characters of only one of the parent shoots, was interpreted to emphasize the fact, already recognized, that the inheritance of a character and its expression are two quite different phenomena.

Sex Latency in the Gametophyte of Onoclea struthiopteris F C Newcombe University of Michigan

The experimental work of Miss Wuist on the sex of the gametophyte of *Onoclea struthiopteris* showed, as published last year in the *Botanical Gazette*, that the female gametophyte may be made to give rise to antheridia Miss Wuist's later work has shown that spores of the same species, which formed at first narrow ameristic plants bearing antheridia, subsequently developed heart shaped proliferations at their apices bearing archegonia To stimulate the outgrowth of the archegonia bearing proliferations, the antheridia bearing gametophytes were transferred from humus soil in pots to a Knop's solution, where they produced the meristic, heart-shaped, secondary gametophytes with their archegonia

Reversible Sex mutants in Lychnis dioica George Harrison Shull, Station for Experimental Evolution, Carnegie Institution

Hermaphrodite mutants were discovered in 1908 in cultures of *Lychnis dioica*, and the following year a report was made on the first generation cross of these with females and normal males The present paper presents data from more than one hundred families in which these hermaphrodites were used, most of these families representing the second generation from the original hermaphrodites It is shown that the hermaphrodite character is a modified male condition, not due to the presence of an independent modifying factor which was suggested by Correns, but obviously a modified condition of the male-producing gene itself The hermaphrodite character is not transmitted by the egg, but only by the sperm Among the offspring of these hermaphrodites have appeared a few normal males in such small proportions (a small fraction of one per cent) that they can only be considered male mutants, since they also breed true to their male character The appearance of hermaphrodite mutants in families produced from normal males and the appearance, in turn, of male mutants in families produced by hermaphrodites, suggest reversible modifications of a single gene rather than the addition of a gene to those previously present, and a subtraction of a gene from them These results may thus have an important bearing upon the "presence and absence" hypothesis.

An Isolated Prairie Grove and its Ecological Significance: Henry Allan Gleason, University of Michigan

Bur Oak Grove is located in Champaign County, Ill , and is about one by three miles in size. It is peculiar in being located at some distance from a stream and surrounded on all sides by prairie, while most of the forest tracts in central Illinois are along the larger water courses The prevailing trees in the grove are *Quercus velutina, Q. imbricaria, Q. macrocarpa, Carya ovata, C. cordiformis* and *Juglans nigra*, with scattered individuals of other species The variation in the composition of the forest indicates that it migrated into the region from the southeast. The grove is not continuous, but is broken by areas of low ground which contain permanent standing water On the moraine north of the grove are found some plants which are regarded as forest relics, now growing in the prairie It is concluded that the whole moraine was formerly covered with forest, which extended also some distance out on either side Since the introduction of prairie fires this forest has been destroyed, except Bur Oak Grove, which is protected by the standing water against attacks of fire The more general conclusion drawn is that forests were formerly of much wider extent in Illinois than at present, but it is distinctly stated that the prairies do not owe their origin to prairie fires

Evaporation in its Relation to the Prairie Problem B Shimek, Iowa State University.

The fact that surfaces exposed to the south and southwest in the Mississippi Valley are treeless has been frequently noted Where changes in topography are abrupt the transition from forest to prairie is likewise abrupt The prairie plants are essentially xerophytic, the forest plants mesophytic The former are found upon the surfaces exposed to sun and summer winds, the latter in sheltered places. Field observations on rate of evaporation on treeless and forested areas, made in western and northwestern Iowa, show that it is much greater on prairie surfaces than in the adjacent forest, and materially greater than on contiguous areas which had been covered with forest but are now cleared. This is true even in the vicinity of larger bodies of water. The results of these observations are presented in tabulated form, and are represented by curves. They show that evaporation increases with temperature and velocity of the wind, and that when the temperature is high the fluctuations in evaporation are caused by changes in wind velocity. The bearing of these results upon the prairie problem is discussed.

Structure of Adult Cycad Trunks: Charles J. Chamberlain, University of Chicago.

While the structure of the cycad seedling is

fairly well known, comparatively little attention has been given to the structure of the adult plant, doubtless on account of the difficulty of securing material.

In an adult stem of *Zamia floridana* 5.5 cm. in diameter the zone of vascular tissue was 2.5 mm. in width. In a plant of *Ceratozamia mexicana* with a stem 14 cm. in diameter the zone measured 5 mm. in width. In *Dioon edule* a stem 21 cm. in diameter showed a vascular zone 9 mm. wide. Compared with these narrow zones, the vascular zone in *Dioon spinulosum* is surprisingly wide, reaching a width of 7.5 cm. in a trunk 32 cm. in diameter.

In *Dioon spinulosum* there are definite growth rings but they are not annual, for not more than one ring is formed in a dozen years, or perhaps in twenty. Medullary rays are as prominent as in a dicotyl. *Dioon edule* also shows growth rings but they are not so prominent as in *D. spinulosum*. No growth rings were found in the specimen of *Ceratozamia*.

In none of these specimens were there any zones of wood in the cortex. It is possible that the periodicity which in *Cycas* produces a zone of wood in the cortex, produces in *Dioon* a growth ring resembling the annual ring.

Spruce Burls: HERMANN VON SCHRENK, Missouri Botanical Garden.

The author describes some burls observed in certain parts of Maine and Minnesota on the white spruce. They occur on all parts of an affected tree, either singly or in large numbers on one tree. The external appearance of the burl is described and their internal structure. Attention is called to the formation of diamond shaped holes, which are probably the result of unequal strains.

The Origin of the Blepharoplast in Polytrichum: C. E. ALLEN, University of Wisconsin.

A dark-staining granule, the center of a system of radiations, appears in the cytoplasm of each cell of the penultimate antheridial generation. In previous cell generations there were kinoplasmic bodies of varying forms whose behavior was definitely related to spindle formation; but no structure that seems genetically related to the centrosome-like body that participates in the final division.

This central body divides; the two daughter granules, each surrounded by an aster, diverge until they lie at opposite sides of the nucleus, and a rudimentary spindle appears between them. The central bodies are conspicuous until about the time of the disappearance of the nuclear membrane; from this time on, they stain less deeply, some of the polar radiations disappear; and, although a granule can usually be recognized at either spindle pole which is probably the central body already described, its identity is often uncertain, and sometimes no such granule is visible.

After cell division is completed, a conspicuous body is again visible in each daughter cell, usually appearing to lie in the neighborhood of the former spindle pole; this body functions as a blepharoplast. There seems no reasonable doubt that the blepharoplast is identical with the previously present central body, which persisted during the division of the mother cell, although the lessened affinity of the central body for stains made it less conspicuous at certain stages.

The Method of Chromosome Reduction. R. R. GATES, Missouri Botanical Garden.

I have previously suggested that in some plants reduction takes place by telosynapsis, and in others probably by parasynapsis. Comparative studies have confirmed this view, but the difference between telosynapsis and parasynapsis is not believed to be of hereditary or phylogenetic significance. Rather is it merely a matter of cell mechanics, long, thread-like chromosomes usually pairing side by side and short ones end to end. The only essential and universal feature of meiosis is the segregation of the members of homologous pairs of whole somatic chromosomes. The function of synapsis is not to bring about a pairing of these homologous chromosomes, because they are paired throughout the sporophyte or soma. Neither is it to effect an interchange of chromomeres or other particles, since the chromosome is considered the unit of morphological nuclear structure; or even of "influences," since this could take place equally well or better in any "resting" nucleus. Synapsis is, therefore, not the final delayed act of fertilization, and is not of fundamental significance in the life cycle. It is, partly at least, explained by the change in the karyoplasmic relation which takes place during synapsis, owing to the fact that a segregation of chromosomes is intercalated between two ordinary mitoses.

On the Organization and Reconstruction of the Nuclei in the Root-tips of Podophyllum peltatum. JAMES BERTRAM OVERTON, University of Wisconsin.

Although a number of valuable papers, dealing with vegetative nuclear divisions, have recently appeared, notably those of Van Wisselingh

Grégoire and his students, Haecker, Strasburger, Bonnevie, Němec and Lundegård, a detailed account of the behavior of the chromosomes during rest has until recently been largely neglected. I have endeavored to follow in detail the various changes which the chromosomes of the telephase undergo during their passage into the resting nucleus, to follow their structural changes and arrangement in the resting nuclei, and also to determine how the visible chromosomes are reformed preparatory to division. During the passage of the chromosomes from the equatorial plate to the poles, they exhibit a progressive alveolation and vacuolation. Transparent spots appear in each chromosome. Each chromosome is composed of chromatic granules, closely massed in a linin substratum. By means of the progressive alveolation and vacuolation these chromatic granules are eventually separated. This process continues until conspicuous anastomosing vacuoles appear on the inside, increasing the size of the chromosome. These enlarged chromosomes often touch each other laterally, but never anastomose, as has been described by some authors. Each chromosome ultimately forms an independent reticulum. The reticulum of the resting nucleus thus consists of a number of these smaller elementary reticula. Conversely, during the earlier prophases of division, the chromosomes become more condensed and distinct and, joining end to end, give rise to the spirem, which is at first broad and reticulate, but eventually becomes densely chromatic. The mature spirem is not continuously chromatic, but consists of the individual condensed chromosomes united serially by visible linin intervals. In the writer's opinion the results strongly support the view of the individuality of the chromosomes.

The Nuclear Conditions in Certain Short-cycled Rusts: EDGAR W. OLIVE, South Dakota State College.

Two general types of short-cycled lepto- and micro-rusts have been recognized with reference to the time of inauguration of the binucleate condition. In one type, the binucleate condition arises at the base of the young teleutospore sori. This type is illustrated by *Puccinia elegans*, *P. asteris* and *P. malvacearum*. In the other type, the binucleate condition arises at some indefinite point earlier in the life history, in the vegetative mycelium. Illustrations of this type are apparently more numerous.

Except the one species, *Puccinia elegans*, in which sexual cell fusions have already been worked out, the method of initiation of the binucleated condition is still problematical.

In two forms, evidences of occasional multinucleated cells were found in the young sori.

Uromyces Rudbeckiæ was found to present an enigmatical variation, in that all the cells, teleutospores as well as vegetative mycelium, were discovered to possess each but one nucleus. No explanation can be offered at present for this unique phenomenon.

Teratological Forms of Oxycoccus macrocarpus: C. L. SHEAR, U. S. Department of Agriculture.

A malformation of the cranberry plant, of both economic and scientific interest, occurs about Grand Rapids, Wis. Metamorphy of the floral organs is the most important and striking characteristic of the trouble. The flowers become erect instead of drooping, the calyx and corolla, and frequently the stamens and pistil, are changed into leaf-like structures. In the most aggravated cases the floral axis is elongated and the floral organs are represented by whorls of small leaves, or the flower may be replaced by a slender shoot bearing small alternate leaves. No insects or fungi have been found to bear a causal relation to the malformation. It is believed to be due, primarily, to prolonged and excessive stimulation of vegetative growth.

Rust of Tsuga canadensis: PERLEY SPAULDING, U. S. Department of Agriculture.

Collections of the rusts occurring on *Tsuga* have been made for several years. Most of them have proved to be *Peridermium Peckii*. This ranges from Wisconsin to northern New York and Vermont, southward to North Carolina. It has been collected on the new host *Tsuga caroliniana* in North Carolina by Dr. A. H. Graves. The collections not belonging to *Peridermium Peckii* were separated into two forms: one on the young shoots, and the other on the green cones, in both cases on *T. canadensis*. The latter form is named *Cæoma tsugæ* sp. nov. The former presents no apparent specific difference from the latter, and it is for the present considered identical with it. Fresh material is necessary to determine this point with certainty, however.

A Plea for Organized Research in the Tropics: PEHR OLSSON-SEFFER. (Introduced by Wm. Trelease.)

A general discussion of the history of scientific research as carried on by various nations, with a special consideration of the conditions in tropical America and the numerous possibilities for work in all lines of botany.

American Botanical Societies and Meetings W. F. GANONG, Smith College.

Report upon the results of an inquiry among a number of botanists regarding the present relations of the various botanical societies and the methods of conducting the meetings

GEORGE T MOORE,
Secretary

THE SECOND ANNUAL MEETING OF THE AMERICAN SOCIETY FOR PHARMACOLOGY AND EXPERIMENTAL THERAPEUTICS [1]

THIS society had a very successful meeting at the Yale Medical School and the Sheffield Scientific School, the Physiological and Biochemical Societies met at the same time

The following program was presented, unusual i terest was taken in the discussions

W Salant, "The Pharmacology of Oil of Chenopodium"

A S Loevenhart, "Further Observations on the Action of Iodoso- and Iodoxybenzoic Acids"

C W Edmunds and W W Hale, "Physiological Standardization of Ergot"

L G Rowntree (with J T Geraghty), "Additional Data relating to the use of Phenolsulphonephthalein as a Functional Test for the Kidney"

H. C Wood, Jr, "The Vaso-motor System of the Pulmonary Circulation"

C. J Wiggers, "The Modifying Influence of Anemia on the Actions of some Well known Drugs."

L G Rowntree and J. J Abel, "Further Experiments in the Field of Specific Chemo-therapeutics."

T S Githens and S J Meltzer, "The Control of Strychnine Poisoning by Means of Insufflation and Ether"

C. W Green, "The Action of Strophanthin on the Isolated Mammalian Heart"

G Carr (by invitation), "The Action of Acetanilid on Cardiac Muscle"

W. Salant (with J B Rieger), "The Elimination of Creatin and Creatinin after the Administration of Caffeine."

W Salant (with I K Phelps), "The Influence of Caffeine on Protein Metabolism"

C. Voegtlin (with B. M Bernheim), "The Rôle of the Portal Circulation of the Liver in Bile Formation and Jaundice."

H G Barbour (by invitation) and J. J. Abel, "Tetanic Convulsions in Frogs produced by Acid Fuchsin and their Relation to the Problem of Inhibition in the Central Nervous System"

J Auer and S J Meltzer, "On Intramuscular Absorption"

D R Joseph and S J Meltzer, "The Action of Sodium Chloride upon the Phenomena following the Removal of the Parathyroids in Dogs"

W J Gies, "Experiments with Salts of Aluminium and Beryllium"

The following new members were elected S P Beebe, Cornell University Medical College, New York, R B Gibson, University of Missouri, P H Hiss, Jr, Columbia University, Paul Lewis, University of Pennsylvania, L B Mendel, Yale University, Isaac Ott, Medico Chirurgical College, Philadelphia, J H Pratt, Harvard University

The following officers were elected for the year 1911

President—J J Abel

Secretary—Reid Hunt

Treasurer—A S Loevenhart

Additional Members of Council—W deB Mac Nider, G B Wallace

Membership Committee—S J Meltzer, C W Edmunds, Torald Sollmann

The following resolutions were adopted concerning the recent death of Dr C A Herter, one of the charter members of the society

"By the death of Dr. Christian A. Herter, one of its charter members and founders, the American Society of Pharmacology and Experimental Therapeutics has suffered a loss which it can but inadequately express Dr Herter's breadth of view, his intimate knowledge and grasp of vital experimental problems, his clearness of expression and his valuable contributions to medical science made his connection with the society of great value to it His encouragement and ever ready assistance in the work of younger men, his appreciation of their difficulties, his own constancy in adhering to the high ideals of earnest and sincere work which he taught to them have made his death a personal loss to each individual member

"The sorrow felt by the members of the society, however deep it may be, is but a small part of the general sorrow felt by the large number of men throughout this country with whom Dr Herter came directly or indirectly in contact The society desires to express its share of this sorrow, however, and it is therefore

"*Resolved*, that there be spread upon the record of its minutes this expression of its feeling of loss at the death of Dr. Herter, of its sincere

[1] New Haven, Conn., December 28–30, 1910

appreciation of his work and of its deep admiration of his personal character

Committee { Reid Hunt
George B Wallace
A N Richards"

Hygienic Laboratory,

Reid Hunt,
Secretary

SOCIETIES AND ACADEMIES

THE BIOLOGICAL SOCIETY OF WASHINGTON

The 477th regular meeting of the society was held January 6, 1911, with President David White in the chair and fifty one persons present

Two new members were elected and standing committees announced by the president

Barton W Evermann reported observations on the fly catching habits of the common brown rat

C D Marsh called attention to a report by Sars on crustacea from Lake Tanganyika, and stated that the list, so far as copepods are concerned, fails to bear out the theory that this lake is of very ancient origin

The following communications were presented

Notes on the Aspens I Tidestrom

The speaker gave the history and relationship of several American and European forms of the genus *Populus* He showed that the western quaking aspen differs in several particulars from the eastern, and proposed a new name for the western form A number of herbarium specimens illustrated the remarks

Some Nesting Habits of Water Ousels and Cuckoos Ned Dearborn

The remarks were illustrated by photographs of the birds and nests The observations on the water ousel were made in Spearfish Canyon, S D, and in Santa Fe Canyon, N M, during last summer, those on the black-billed and yellow-billed cuckoos were made at Joliet, Ill, in 1906

A Recently Imported Enemy of Alfalfa F M Webster

The alfalfa or lucern weevil (*Phytonomus murinus*) was introduced into this country, probably in the packing or in packages of articles of international commerce, some time prior to 1904, when it was first discovered by the entomologists of the Utah Agricultural Experiment Station attacking a small field of alfalfa in the vicinity of Salt Lake City, Utah From this point it has since that time spread over the country northward to near Ogden and southward to beyond Provo and from a considerable distance westward of Tooele, very nearly to the borders of Wyoming

The eggs are deposited chiefly in punctures made in the young stems by the adult beetles, the larvæ, as soon as they hatch, make their way to the tender growing crowns of the plants, feeding upon the unfolding leaves and tender stems, and thus prevent growth of the young plants. Later on in the season, after the insects have reached the adult stage, these still attack the alfalfa plants by gnawing the bark from the stem, thus destroying them

In many alfalfa fields about Salt Lake, at the time for mowing the first crop of hay, the plants had not made sufficient growth to admit of mowing, while the second crop was seriously damaged by the feeding of the adult beetles as just described Approximately, damage to the amount of a half million dollars was caused during the last year by this pest in Utah

No thoroughly practical measures have been found for preventing the spread of the pest or very materially reducing the results of its depredations

The habit of the adults in hiding away in baled hay, in fruit packages, or almost any other similar articles of commerce, as well as their attaching themselves to freight cars and hiding themselves in the vestibules of Pullman sleeping cars, makes their diffusion by railways almost unpreventable Twenty seven individuals were taken from the vestibule of one sleeping car attached to a train at Salt Lake City last July Also, the adult insects fly about freely during the summer and being carried by the winds are also in this manner widely diffused

The present indications are that the insect will make its appearance in southern Idaho, southern Wyoming and eastern Nevada the coming spring Fortunately, alfalfa does not enter into international commerce as does cotton, therefore this insect is not likely to affect articles of international commerce. But over the western country, where it seems likely to diffuse itself and carry on its destructive work, there is much territory where alfalfa is the only crop that can be raised, and if this is destroyed the farmers will be placed in sore straits and confronted with a more serious problem than is brought about by any other insect known to occur in this country Over a good portion of the country west of the one hundredth meridian alfalfa is the money crop of the farmers, and any influence tending to prevent or interfere with the cultivation of this, will constitute a calamity throughout that country

The insect has no natural enemies excepting frogs and toads Birds do not appear to relish them. No insect enemies are known, or have yet been discovered, and fungus diseases that attack similar larvæ in the east have failed to become established when introduced from the eastern part of the country.

D E LANTZ,
Secretary

THE HELMINTHOLOGICAL SOCIETY OF WASHINGTON

THE first meeting of the society was held in the rooms of the zoological division of the Public Health and Marine Hospital Service on October 8, 1910, Dr Stiles acting as host, Dr Garrison as chairman Mr Hall was elected secretary for the year

Dr Pfender noted the publication of a recent article recording the finding of *Necator americanus* in New Guinea for the first time

Dr Garrison exhibited specimens of *Davainea madagascariensis* from man and read a paper, to be published in the *Philippine Journal of Science*, dealing with the case and describing the specimens The material, consisting of one complete and four incomplete and headless specimens, was collected from an adult male native in the Philippines It is the first case from this locality and the tenth recorded case This case indicates a more or less general distribution of the parasite throughout the tropics Cases occur in children and adults and the lack of records from any host save man since the parasite was first found in 1867 indicates that man is the normal host So far the parasite has been recorded only from coast regions, but this may be due to inadequate investigation in the interior Dr Garrison's description of the anatomy was illustrated by photographs

Dr Stiles gave a talk on the International Zoological Congress at Gratz He discussed the newly elected international committee on medical zoology and noted the following plans which the committee had taken up the agreement on national repositories for collections dealing with medical zoology and for the deposition of type material; a working agreement between this committee and the Commission on Zoological Nomenclature to determine and fix upon the correct names of the parasites of man and later of those of domesticated and the more important wild animals; the securing of material from the various groups for the use of specialists; the location of existing collections and especially type specimens; the securing of better recognition of zoology in medical schools where work in tropical medicine is done, and the issuing of a model syllabus for such a zoological course, the collection of methods of technique, and the selection of corresponding members with a view to promoting harmony and cooperation and avoiding dissension and unwarranted criticism in zoological circles

THE second regular meeting of the society was held in the rooms of the zoological division of the Hygienic Laboratory, December 1, 1910, Dr Stiles acting as host, Dr Ransom as chairman.

Dr Stiles presented an abstract of an unpublished paper on rural sanitation, with special reference to the disposal of fæces A proper disposal of fæces is the greatest single factor in combating zoo parasitic diseases Where the installation of a sewer system is not feasible, the dry disposal method has been considered the best In this the fæces are covered with dirt or lime The system depends on the cooperation of all of the members of the community for its success, and this fact constitutes one of the greatest objections to it Children and the majority of the southern negroes can not be depended on to cooperate The unsatisfactory character of this system being evident, efforts have been made to devise a satisfactory wet system Many tests had given unsatisfactory results, but the wet system devised and described by Lumsden, Roberts and Stiles seems to have overcome the final objections. The paper dealt also with the objections to the dry system as they had been worked out at Wilmington, N C Some of the findings were as follows (1) The sand under and around dry system privies is not safe five months after the last use of the privy Sand which had been dried out twice showed two encysted larvæ on the one hundred and fifty-first day. Life was not demonstrated by movement, but the specimens were histologically perfect and could not have been dead more than a day or two if they were dead (2) After four months the infection may be greatly reduced and in some cases perhaps entirely eliminated (3) After five months in sand, and after drying out twice, live *Ascaris* eggs may be found after all the hookworm eggs and embryos have perished. *Ascaris* eggs were found apparently alive after 156 days. (4) Hookworm eggs were identifiable after 151 days (5) When fæcal material is subjected to water decomposition for 70 days, most of the hookworm eggs die, but some are still alive. (6) No hookworm eggs were found alive after about four to five months in fæces and water. (7) It is probable

that hookworm eggs perish in three months in fæcal material in water. If this is proved, then the effluent from the L R S barrel privy should be stored three months before using as fertilizer. The use of fæces as fertilizer is receiving especial attention for the reason that the commercial argument carries more weight with some people than does the idea of protection to human life and health. (8) In fæces decomposing in water, 80 per cent. of the *Ascaris* eggs are dead in four or five months, but some are still alive, thus outlasting the hookworm. (9) Chloride of lime in the proportion of a quarter pound to about ten quarts of water does not kill hookworm eggs in 22 to 40 hours. After four days the eggs are still microscopically normal.

Flies feed and breed in the dry system. In one place about 80 privies were examined. Although lime was furnished free, it was only used generously in three cases, and flies were breeding in these places as in the others. The fæces are collected in wagons and buried; burial under a foot of soil being recommended. The carts carry and distribute flies. Experiments showed that flies developed and crawled up to the surface from fly-blown fæces buried under six and a half inches of sand, they came through 17 inches in 24 hours; and flies issued after burial under 48 inches of sand. Flies were obtained even after burial under six feet of sand. In the last two cases, the sand used was not sterilized but was pure sand carefully selected. These are final arguments against the dry system.

The system favors the sporulation of amœbæ. Flies can bring to the surface and distribute amœbæ spores or typhoid bacilli. Under some circumstances privies may be more important than the manure piles as breeding places for flies.

Dr. Stiles presented a note on spurious parasitism. Small oligochætes were sent in from three different states in three cases recently, with the claim that they were passed in the urine. These are assumed provisionally to be cases of contamination. In one case, however, it was claimed that they were passed in the presence of a physician and into a clean receptacle. A specimen of a small snake, identified by Dr. Stejneger as *Storeria dekayi*, was exhibited. This specimen was sent in from Pennsylvania with the claim that it had been passed from the bowels.

Dr. Cobb presented a note on the abundance of free-living nematodes in the soil. The number per acre amounts to thousands of millions. Reckoning the average length at one and one half millimeters, a modest estimate, the nematodes in one acre would extend from Washington to Chicago if placed end to end. One genus feeds almost exclusively on diatoms.

Dr. Garrison brought up the question as to the desirability of designating certain tropical stations as repositories for zoological material connected with the study of tropical medicine. Dr. Stiles stated that the international commission hoped to take up that subject in the not too distant future.

Dr. Ransom gave a brief summary of a paper entitled "The Nematodes Parasitic in the Alimentary Tract of Cattle, Sheep and other Ruminants," to be published as a bulletin of the Bureau of Animal Industry. The paper describes 50 species, at least 30 of which occur in the United States, the species described representing 18 genera belonging in the five families Ascaridæ, Strongylidæ, Filariidæ, Angiostomidæ and Trichinellidæ. The Strongylidæ are divided into the subfamilies Strongylinæ and Metastrongylinæ, and the Trichinellidæ are divided into two new subfamilies. Railliet's rejection of the subfamily Strongylinæ, following the application of the generic name *Strongylus* to the so called sclerostomes, and his substitution of the name Ankylostominæ was noted. A *Strongyloides* from the prong-horn antelope was noted as of particular interest. Members of the Angiostomidæ, to which this genus belongs, are characterized by a life cycle including two generations, one of free-living males and females, and another of parasitic hermaphroditic or parthenogenetic forms. In the species in question the parasitic adult molts repeatedly, and the eggs as passed lodge under the old cuticle and are carried away in the old skin when it is shed. It was noted that *Strongyloides longus* of the sheep is certainly identical with Wedl's *Trichosoma papillosum*. Two new species of *Capillaria* are described in the paper.

Mr. Hall gave a summary of a paper entitled "A Comparative Study of Methods of Examining Fæces for Evidences of Parasitism," to be published as a bulletin of the Bureau of Animal Industry. The paper gave the various methods used in examining fæces and indicated the application and limitation of each method on the basis of comparative studies. A new modification of technique which had been found more efficient than other methods was then demonstrated in the laboratory.

MAURICE C. HALL,
Secretary

SCIENCE

FRIDAY, FEBRUARY 10, 1911

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THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

THE RELATIONS OF ISOSTASY TO GEODESY, GEOPHYSICS AND GEOLOGY[1]

WITHIN the past ten years geodetic observations have furnished positive proof that a close approximation to the condition called isostasy exists in the earth and comparatively near its surface.

Let the depth within which isostasy is found be called the depth of compensation. Think of a prismatic column which has for its base a unit area of the horizontal surface which lies at the depth of compensation, which has for its edges vertical lines, and has for its upper limit the actual irregular surface of the earth (or the sea surface if the upper end of the column is in the ocean) The condition called isostasy is defined by saying that the masses in all such columns are equal.

Fig 1 (p. 202) represents two such columns Column A is under the land and column B is adjacent to it under the ocean. If the condition called isostasy exists in two such columns having equal bases they have equal masses Note that if this is true the average density in column A must be less than the average density in column B, for the volume of column A is greater than that of column B. This may be partially expressed by the statement that each excess of mass represented by material lying above sea level is compensated for by a

[1] Address of retiring vice-president of Section D (Mechanical Science and Engineering) of the American Association for the Advancement of Science, at Minneapolis, December 29, 1910, by John F Hayford, director, College of Engineering, Northwestern University, Evanston, Ill

defect of density and, therefore, of mass in the material in the same vertical line below sea level and above the depth of compensation

Note that isostasy is defined in terms of masses and densities without regard to the manner in which this arrangement of masses and densities has been produced.

Isostasy is a condition of approximate equilibrium, not perfect equilibrium The total weight of column A being the same as that of column B, the pressure at the depth of compensation due to weight is the same under the two columns, and at this level there is equilibrium Above any selected higher level in the two columns such as that marked depth X in the figure, the mass is greater in column A than in column B[2] Therefore, at depth X the pressure due to weight is greater in A than in B, equilibrium does not exist, and the material in A at this level tends to move downward and to the right into B

The geodetic observations which have furnished a positive proof that a close approximation to the condition called isostasy exists in the earth are, first, 765 series of astronomic observations scattered over the United States from the Atlantic to the Pacific and from Canada to Mexico, and all connected by continuous triangulation,[3] and, second, determinations of the intensity of gravity at 89 stations scattered over the whole of the United States.[4]

The geodetic observations show that the most probable depth of compensation is 76 miles and that it is practically certain that it is not less than 62 nor more than 87 miles.[5]

Let the isostatic compensation be considered complete if in every column, such as those shown in Fig 1, the mass above the depth of compensation is the same as in every other column If the mass is greater or less than this in any one column, let us characterize the isostatic compensation as incomplete and measure the degree of incompleteness in terms of the excess or defect of mass

The geodetic observations show that the isostatic compensation under the United States is nearly complete It is not merely a compensation of the continent as a whole, it is a compensation of the separate, large, topographic features of the continent

[2] The density in column A, in which a defect of density exists to compensate for the excess of mass at the surface, being less than in column B, in which the reverse condition exists, the mass in column A below depth X is necessarily less than in column B below that level Hence the total masses in the two columns being equal, the mass in column A above depth X must be greater than in column B, as stated

[3] The evidence from these observations is given in full in "The Figure of the Earth and Isostasy from Measurements in the United States" and "Supplementary Investigation in 1909 of the Figure of the Earth and Isostasy," both by John F Hayford and both published by the Coast and Geodetic Survey.

[4] These have furnished evidence which corroborates that from the astronomical observations and triangulation This evidence has not been published except in brief and incomplete form (report of the sixteenth general conference of the International Geodetic Association, Vol 1, pp. 365–389, "The Effect of Topography and Isostatic Compensation upon the Intensity of Gravity," by John F Hayford), but it will probably be published in full within a year in a paper which is being prepared by Mr William Bowie, inspector of geodesy, Coast and Geodetic Survey, and the speaker It is expected that this will be published by the Coast and Geodetic Survey under the same title as the report presented at the International Geodetic Association to which reference has just been made

[5] This is the depth of the compensation if uniformly distributed with respect to depth, which seems to be the most probable assumption If the compensation is distributed in some other manner with respect to depth, the limiting depth of compensation is different, see pp 77–78 of the "Supplementary Investigation in 1909 of the Figure of the Earth and Isostasy"

There is an excess of mass in some columns and a defect in others, but the evidence indicates that the average excess in the areas of undercompensation is properly represented by a stratum only 250 feet thick having the same density as the surface portion of the earth (2.67). Similarly, the average defect of mass in the areas of overcompensation corresponds to a stratum only 250 feet thick.

Contrast these small excesses and defects of 250 feet with the actual elevations in the United States, 2,500 feet on an average for the whole country. If there were no isostatic compensation these actual elevations would represent excesses of mass. The compensation may properly be characterized as departing from completeness only one tenth on an average.

These are the facts, established by abundant geodetic evidence. These facts may not be removed or altered by showing that difficulties are encountered when one attempts to make them fit existing theories geological or otherwise. The theories must be tested by the facts and modified if necessary.

A close approach to the condition called isostasy certainly exists. It is uncertain how this condition has been produced; upon that point the geodetic observations furnish no direct evidence.

The recognition of isostasy in a definite and reasonable manner in the computations of the figure and size of the earth from astronomical observations and triangulation has nearly doubled the accuracy of the computed results. This recognition, combined with other improvements in methods of computation, has enabled the Coast and Geodetic Survey to compute the equatorial radius and the flattening of the earth from observations in the United States alone with greater accuracy than it was formerly possible to compute it from all the observations of the world combined—by such computations, for example, as those made by Bessel and Clark.

The evidence is clear that the present isostatic compensation is not an initial condition which has persisted since early geologic times. There is abundant geological evidence[6] that within the interval covered by the geologic record many thousands of feet of thickness of material have been eroded from some parts of the United States and adjacent regions and deposited in other parts, that changes of elevation of the surface amounting to thousands of feet have been produced in this and other ways, and that these changes have continued to take place in recent time. Hence it is evident that if there had been complete isostatic compensation in early geologic time, and no readjustment toward the isostatic condition had taken place since, the departure from complete compensation would now be measured by strata thousands of feet thick upon an average. In fact, the present departures from complete compensation are measured by strata only a few hundred feet thick—250 feet on an average. It is certain that a readjustment toward isostasy has been in progress during the period covered by geologic record.

Let us consider the tendency of gravitation to produce readjustment toward isostasy. Recur to the case indicated in Fig. 1. Columns *A* and *B* have been assumed to contain equal masses. There is complete isostatic compensation. The pressures at the bases of the two columns

[6] The paper entitled "Paleogeography of North America," by Charles Schuchert, pp. 427–606 of volume 20 of the *Bulletin of the Geological Society of America* may be cited as an example of such evidence marshaled in systematic form. Consult the fifty maps at the close of this publication for a graphic indication of the changes which have probably taken place on this continent.

are equal, and at any less depth, X, the pressure is greater in A than in B Now assume that in the normal course of events a large amount of material is being eroded from the high surface of column A and deposited on the low surface of column B After this erosion has been in progress for some time the isostatic compensation will no longer be perfect. The pressure at the base of B will be greater than at the base of A The pressure very near the top of B will still be less than at the same level in A so long as the top of A remains higher than the top of B. There will be some intermediate level at which the pressure in the two columns is the same. Call this level of temporary equality of pressure in the two columns the neutral level As the process of erosion and deposition progresses the neutral level will gradually progress upward from its original position at the base of the columns Eventually if no interchange of mass took place between the columns except at the surface, and no vertical displacement occurred in either column, the neutral level would reach the surface when the process of erosion and deposition became complete and the upper surfaces of the two columns were at the same level. During the process of erosion and deposition the excess of pressure in A at any level above the neutral level will continually decrease Similarly, at any level below the neutral level the excess of pressure in B will continually increase as the erosion progresses and the neutral level will rise Thus there will be established a continually increasing tendency for the material below the neutral level in B to be squeezed over into A. If the stresses tending to produce this undertow from the lower part of B to A become greater than the material can stand, the flow will take place as indicated by the arrow in the figure If the material flows without change of volume, as if it were incompressible, the upper part of A and its surface will be raised, the upper part of B and its surface will be lowered, the neutral level will sink and an approximation to the original conditions with complete isostatic compensation will be reestablished.

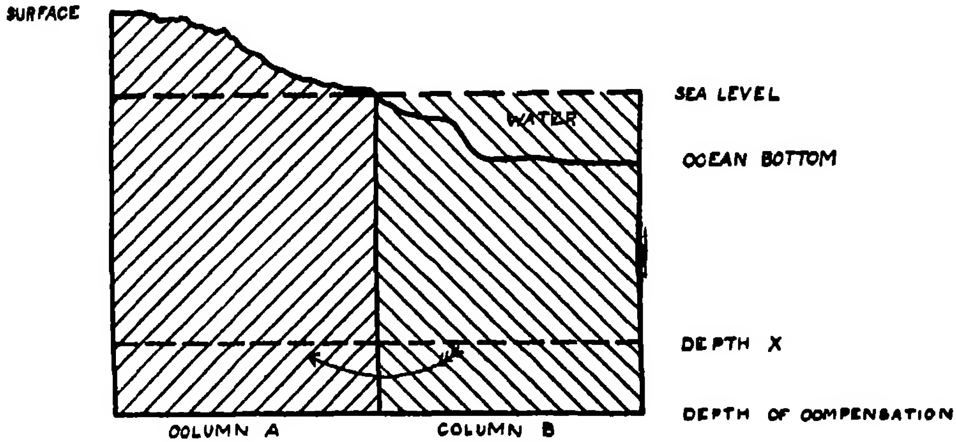

Fig. 1

This is the general case of isostatic readjustment by the action of gravitation alone. Gravitation tends to produce a deep undertow from the regions where deposition is taking place to the regions

where erosion is in progress, in the direction opposite to that of the surface transfer of material

Let us suppose that the isostatic compensation at a given stage in the earth's history is practically complete for a continent, that the process of erosion from the greater part of the continent and deposition around its margins is in progress, and that the process of readjustment by a deep undertow is in progress These processes will cause changes of pressure and temperature within the earth at certain places. It is important to study the probable effect of these changes upon the condition and especially upon the density of the material involved

At this point, in order to keep our subject in proper perspective, it is desirable to recall that the average defect in density under a continent corresponding to complete isostatic compensation is one per cent or less, the average excess of density under an ocean only about two per cent. and the maximum defect or excess under the highest parts of the continents or under the deepest parts of the ocean are but little greater than three per cent These are very small differences in density Differences larger than these are frequently observed between samples supposed to be alike.

If a layer of material 1,000 feet thick is eroded from one part of the earth's surface and deposited on another part the pressures must become appreciably reduced for a considerable distance below the eroded region and increased below the region of deposition. The heterogeneous material composing the earth is continually undergoing chemical changes. The expression chemical change is here used in its widest sense, the sense in which it includes the processes of solution, crystallization and changes of state between the solid, liquid and gaseous forms, includes the solution of gas in liquids, the solution of rock ingredients in water and their redeposition as new materials different from the original materials, and changes from an amorphous to a crystalline state, and vice versa All these and more are concerned in the complicated processes of metamorphism In the heterogeneous mixture at any point in the earth a great many changes are impending A relief of pressure at any given point tends to favor such changes as are accompanied by increase of volume and reduction of density, and an increase of pressure tends to have the reverse effect Many of these suggested chemical changes are accompanied by a change of much more than three per cent in density Changes of this nature in a small part of the material in any cubic mile may alter the average density as much as three per cent

A large reduction of pressure may reasonably be expected, by favoring certain chemical changes within the earth and opposing others, to bring about gradually with the lapse of ages a decrease of two or three per cent in the density of the material relieved of pressure

Under a region where erosion is in progress or has recently been in progress one should expect, therefore, that the chemical changes guided by reduced pressure will gradually produce increase in volume and a raising the surface, and conversely, under a region of deposition the chemical changes guided by increased pressure will gradually produce increase of density, reduction of volume and a lowering of the surface The surface changes will then favor more erosion and more deposition in the same regions as before. During this process the stresses due to gravitation, tending to produce an undertow and thereby an isostatic re-

adjustment, gradually increase until an undertow takes place and the isostatic condition is restored or nearly restored In this last state the surface of the continent will still be elevated, its margins will still be low and the processes of erosion, deposition and isostatic readjustment by an undertow will still tend to continue

Note that the processes just indicated explain the existence of defective density (light material) in the continent and to great depths below the surface, not by the supposition that the light material was there originally, but by the supposition that the processes of chemical change are such as to increase the volume and decrease the density of the material after it is in position as a part of a continent

In studies of the earth it is frequently assumed tacitly that the material is sensibly incompressible under changes of pressure produced by the shifting of loads, by erosion and deposition It would be as sensible as this supposition, not more absurd, to compare the material beneath an eroded surface to the contents of a vichy siphon Upon a slight reduction in pressure, of a few pounds per square inch, the contents of a vichy siphon double their volume in a few seconds After the reduction of pressure caused by the erosion of a layer a mile thick from the surface of the earth in a given region the material below to a depth of 76 miles probably changes its volume by one per cent in the course of the next few ages

Now consider the effects of the changes of temperature which would be produced by the erosion, deposition and undertow which have been indicated

Near the surface the temperature is known to increase about 1° C. for each 100 feet increase in depth below the surface At great depths the rate of increase is probably much smaller Assume that it is 1° C for each 200 feet on an average down to the depth of compensation, 76 miles Then if a stratum 1,000 feet thick is eroded from a region the temperature will be lowered under that region in the course of ages by 5° C upon an average to the depth of 76 miles Assuming that the coefficient of vertical expansion is 1 part in 60,000 per degree Centigrade, the material to the depth 76 miles will contract 1 part in 12,000 in thickness or 30 feet On these assumptions then for every 1,000 feet eroded there is a tendency to produce by cooling and contraction 30 feet of sinking of the surface, that is, one foot of sinking by thermal contraction for each 33 feet of erosion It is unimportant whether this ratio 1 33 is a close approximation It is important to note that whereas the reduction of pressure caused by erosion tends to make the material expand, the lowering of temperature caused by erosion tends to make the material contract, an opposite effect

Probably expansion by chemical change begins to occur promptly after a certain amount of erosion has occurred, since a change of pressure would probably be felt comparatively promptly even at considerable depths On the other hand, the cooling is necessarily slow and may require ages to penetrate 76 miles Hence following erosion in a given region the expansion due to chemical change will tend to begin first Later, and developing much more slowly, the contraction due to the lowering of the temperature will occur The latter may in time become as rapid or more rapid than the former, the volume may cease to increase or may even decrease, the surface may stop rising or it may even sink, and the region of erosion be changed into one of deposition.

Similarly, under a region of deposition two effects of opposite sign tend to occur.

The effect of increased pressure tends to produce chemical changes accompanied by decrease of volume and so to produce a sinking of the surface The blanket of deposited material tends to raise the temperature in each part of the material covered, to increase the volume of this material, and thereby to raise the surface The temperature effect may serve in time comparatively neutral region between the two in which neither erosion nor deposition is much in excess of the other, see Fig 2 Hence the undertow by increasing the temperature and causing a change of density may be directly effective in changing the elevation of the neutral region between two regions of deposition and erosion

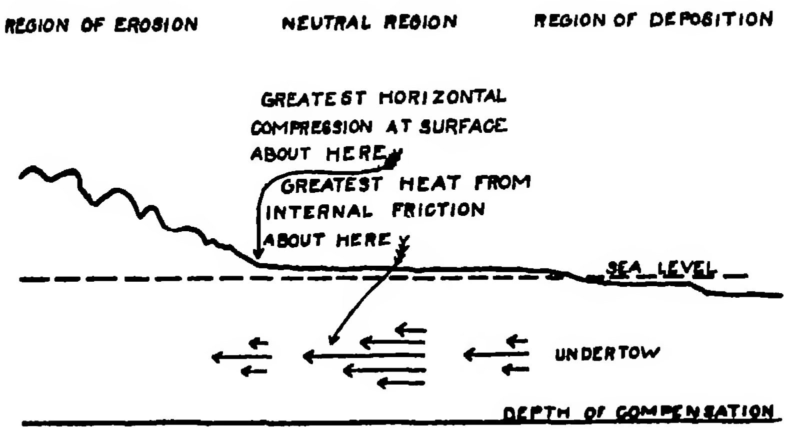

FIG 2

to arrest the subsidence caused by increased pressure or even to raise the surface and change the region of deposition into one of erosion

The changes of temperature just described are due directly to erosion and deposition If as an effect of erosion and deposition an undertow is started tending to reestablish the isostatic condition, this undertow, a flow of material presumably solid, necessarily develops considerable heat by internal friction The increase of temperature so produced tends to cause an increase of volume It may favor new chemical changes, including changes from the solid to the liquid state, which may be accompanied by a change of volume The undertow tends to be strongest not under the region of rapid erosion nor under the region of rapid deposition, but under the

Horizontal compressive stresses in the material near the surface above the undertow are necessarily caused by the undertow For the undertow necessarily tends to carry the surface along with it and so pushes this surface material against that in the region of erosion, see Fig 2 These stresses tend to produce a crumpling, crushing and bending of the surface strata accompanied by increase of elevation of the surface The increase of elevation of the surface so produced will tend to be greatest in the neutral region or near the edge of the region of erosion, not under the region of rapid erosion nor under the region of rapid deposition

There has been indicated a complicated set of changes of pressure, temperature and density and of movements of material beneath the surface, a set of changes which

have been started by erosion and deposition and continued by the action of gravitation tending to bring about a readjustment to isostatic conditions.

Attention is invited to the thought that during the actions indicated the pressure, temperature and relative movements in any small portion of the material are a function not simply of the facts at that place but also largely of the facts at many other places, some at considerable distances.

For example, in the neutral region between a region of erosion and one of deposition there may be movements beneath the surface (the undertow), changes of temperature in the flowing material, a crumpling of the surface material, changes of volume and changes of elevation of the surface, all of which are dependent primarily upon the facts in adjacent regions of erosion and deposition.

Let us limit our thoughts still to the cycle of changes which have been sketched roughly. Keep it in mind that the actions at any given point in the material depend on the facts at many other points. Keep it in mind also that a region of erosion in one age may, and often does, become a region of deposition in another, and that, therefore, the actions taking place at any instant in a given portion of the material are necessarily dependent upon the past as well as the present conditions. Is it not evident that even if the cycles of action which have been indicated were the only actions taking place in the outer portions of the earth, the resulting series of movements observable at the surface would be very complicated? Is it at all certain that under the influence of such actions the geological record at the earth's surface at the end of 50 to 100 million years would be appreciably less complicated than the geologic record which is actually before us? I think that it would be fully as complicated as the actual record.

Let me illustrate, by a single example, the kind of reasoning which the considerations just stated should lead one to avoid.

It has been stated to me that mountains are sometimes eroded to a peneplain, and that thereafter the peneplain sometimes sinks. It has been suggested to me that such a case can not be reconciled with the theory of isostasy. It is said that as the material is eroded from the surface the underlying material must increase in volume to keep the isostatic compensation complete, hence that according to the theory of isostasy a peneplain may rise but never sink.

This reasoning contains several errors. In the first place, in Fig. 1, after a portion of the surface of column *A* has been carried away by erosion and the pressure at the bottom of the column thereby reduced to less than that under column *B*, the mere vertical expansion of column *A* will not reestablish equality of pressure. The equality may be reestablished only by restoring mass to column *A* by forcing material into it from some other column. This gravitation tends to do. Secondly, when gravitation, by producing an undertow, forces material into column *A* the new material may enter by processes which increase the density of column *A*. Column *A* may thus become heavier without any raising of its upper end. An eroded surface does not necessarily rise. Thirdly, a time may come when by virtue of the lowering of the temperature by erosion the material in column *A* may increase in density by thermal contraction and the surface may thus be lowered without any masses passing to other columns. If so, the isostatic condition remains unchanged, the relative pressures at the bases of *A* and *B* remaining unchanged. Such a process

may cause a region which has been eroded from mountains to a peneplain to sink thereafter. Fourthly, such reasoning as that cited ignores the history of the region before the mountains were there. That early history is essential to a full understanding of late movements. Fifthly, such reasoning entirely ignores the relations of the region considered to adjacent regions. As the evidence shows that the material concerned in isostatic readjustment is 76 miles deep, it is but sensible to estimate that the influences concerned in any one movement of isostatic readjustment extend over horizontal distances of at least 76 miles, probably over distances as great as 200 miles Therefore, valid reasoning in regard to the peneplain in question should include a consideration of the conditions surrounding it to a distance of 200 miles, whereas in fact in the reasoning cited the surrounding conditions were entirely ignored.

How is it possible to form an estimate of the relative effectiveness of gravitation tending to produce isostatic readjustment, on the one hand, and of all other forces acting on the outer portion of the earth, on the other hand? Gravitation is the only force which continuously tends to produce isostatic readjustment. The rigidity of the material tends continuously to oppose the readjustment toward isostasy. Other forces than gravitation are equally likely to help or to oppose gravitation. Therefore, the fact that the isostatic compensation is everywhere nearly complete is a proof, first, that the material composing the outer portions of the earth has but small effective rigidity, and, second, that the forces in operation other than gravitation are relatively ineffective. If either of these propositions were untrue the present close approach to complete isostatic compensation would not exist.

Before closing let me remind you that the geodetic evidence shows that the outer portion of the earth is not a solid crust a few miles thick floating on a liquid substratum of slightly greater density.[7]

The existence of isostasy is now thoroughly established by evidence which is available in print. The time has come to speculate upon the manner in which the isostatic readjustments are produced, to look for the relations between the known condition, isostasy, and other known facts. This address is a map showing the results of a reconnaissance in this field The reconnaissance has involved much more thought than I have been able to put into words here Some of the statements have been made in rather a dogmatic form. That is simply because I have tried to draw a clear reconnaissance map with few strokes, not that I have forgotten that the field work has been merely reconnaissance. I feel confident, however, that in due course of time when careful surveys shall have been substituted for this reconnaissance, the main features of this reconnaissance map will be found to be correct.

In closing let me give you the reconnaissance map on a small scale with details omitted

Readjustment toward isostatic conditions has been in progress throughout geologic time

The differences in density involved in complete isostatic compensation are very small, usually less than one per cent., seldom more than three per cent.

With reference to such small changes of density the earth is not incompressible under the influence of stresses which are applied continuously for geologic ages.

Erosion and deposition cause changes of pressure, which in turn bring about

[7] "The Figure of the Earth and Isostasy," pp. 163–164.

changes of chemical state in the heterogeneous material within the earth such that increase of pressure in time produces increase of density, and relief of pressure produces decrease of density.

The direct effects of erosion and deposition on temperatures in the underlying material are such as to cause changes of density opposite to those caused directly by the change of pressure and probably occurring later than those caused by changes of pressure.

Gravitation tends continuously to bring about a readjustment to isostatic conditions by producing a deep undertow from a region of deposition to a region of erosion.

This undertow by virtue of heat produced by internal friction and by virtue of surface compressive stresses in the horizontal direction tends to raise the surface of the neutral region between a region of deposition and one of erosion.

The phenomena of isostatic readjustments by gravitation are complicated. Actions involved at any one spot are a function of the facts at many other places and of the facts of earlier ages.

The material in the earth to a depth of 76 miles is weak under the action of forces applied for geologic ages. The effects of gravitation predominate over those of other forces to this depth.

John F. Hayford

THE MERSHON EXPEDITION TO THE CHARITY ISLANDS, LAKE HURON

For several years the University of Michigan Museum and the Michigan Geological and Biological Survey have been cooperating in a biological survey of the state. The survey has had a small annual appropriation for this work, and has deposited the collections in the museum, but the expeditions sent out from the latter have nearly all been made possible by gifts from persons interested in the progress of the work or in the institution.

In the summer of 1910, Hon. W. B. Mershon, Saginaw, Mich., placed in the hands of the chief field naturalist of the survey, who is also the head curator of the museum, a sum sufficient to send a small party to the Charity Islands in Saginaw Bay, for the purpose of investigating the fauna and flora.

The Charities comprise a group of three small islands situated near the mouth of Saginaw Bay. The largest of these, Charity Island proper, contains about 650 acres, Little Charity Island, the next largest, about 3 acres, and Gull Island is a small projecting reef, about a quarter of an acre in extent, that is not usually shown on the maps. The group is somewhat nearer the west coast than the east. As plotted on the Lake Huron Coast Chart No. 2, of the United States Lake Survey, the distances of the larger island (where most of the work was done) from the mainland are as follows: to Point Lookout, slightly north of west, six and seven eighths miles; from Caseville, due southeast, nine and five eighths miles; from the end of Sand Point, a little east of south, seven and three fourths miles; from Oak Point, south of east, nine miles.

The islands are of interest biologically in two ways. In the first place, as they have not been connected with the mainland since glacial times, the biota must have reached them over a stretch of water at least as broad as that which now separates them from the mainland. In the second place, they are apparently upon a migration route of many species of birds.

The men engaged to do the work and the groups to which they devoted most of their time were as follows: W. W. Newcomb (butterflies and moths), N. A. Wood (vertebrates), A. W. Andrews (beetles), Frederick Gaige (ants), C. K. Dodge (plants). The museum and survey are greatly indebted to these men, for they did the field work without other remuneration than their expenses, and are now preparing their results for publication. Acknowledgment should also be made of the assistance of the light-house board, Washington, D. C., and Commander C. B. Morgan, inspector of the eleventh light-house district,

Detroit, Mich., in granting permission to work on the islands The assistance received in the field will be acknowledged in the several papers

The results of the expedition will be published in various journals and in the annual reports of the Michigan Academy of Science under the common title "Results of the Mershon Expedition to the Charity Islands, Lake Huron" As most of the field work was done in the late summer and fall, the survey plans to continue the work in the spring and early summer of 1911

ALEXANDER G RUTHVEN
UNIVERSITY OF MICHIGAN MUSEUM

ARTESIAN WATERS OF ARGENTINA

THE climate of a part of Argentina is semi-arid, and the geological formations which are regarded as Quaternary and Later Tertiary are in the western and central districts of the country saline to a degree which indicates prolonged duration of aridity The region of the pampas which covers the province of Buenos Aires and stretches northward west of the Parana does not exhibit this characteristic, it having apparently long enjoyed a more humid climate, as it does now The foot-hills of the Andes are also well watered But with the exception of these last-named regions, a great part of the country suffers from lack of good water This condition may, however, be in some measure relieved by proper development of artesian supplies Many wells have been sunk already, but without adequate geological investigation. In the pampas water is found at a general depth of 20 meters more or less, and is pumped to the surface by windmills It may be said that the development of the livestock industry of Argentina would be impossible were it not for this supply which comes from eolian, alluvial deposits of Quaternary and Tertiary age. A different geological condition exists from the Rio Colorado southward in what may be best described as northern Patagonia In that region there are local elevations occupying a middle position between the Atlantic and Pacific, composed of granites and older rocks possibly of Paleozoic age, and rising to altitudes of 300 to 1,000 meters These mountains are not represented upon any map and their distribution is not known, but they have been described by Moreno and other explorers Upon their flanks there is an extensive formation of gray sandstone which attains a thickness of several hundred feet and is very porous It slopes gently toward the Atlantic and pure water flows from it in outcrops near the coast The head of water in these strata is unknown Further south in Patagonia the central sierra is replaced by plateau country and in Comodoro Rivadavia, in latitude 46 near the coast, wells which were sunk by the government in search of water developed petroleum There is a large area in this region in which the geologic structure and the possibilities of artesian water need to be developed In the great plains east of the Andes there are glacial deposits which may furnish superficial supplies like those of the Dakotas, and the marine Tertiary and Mesozoic strata afford conditions not unlike those of southern California Here as well as in the valleys among the spurs of the Andes from Patagonia to Bolivia the geological structure is complicated and the problem of artesian water is one of peculiar difficulty as well as of great interest

Our present knowledge of these conditions rests upon reconnaissance work and the stratigraphic and paleontologic observations of the Geological Survey of Argentina No work based upon topographic maps and systematic structure has as yet been undertaken The problem is therefore one whose elements are as yet to be developed. The Argentine government is using every means to encourage settlement and development of the rich agricultural regions which lie in the zone of sufficient rainfall east of the Andes, and also the vast grazing district of Patagonia In order to afford ready communication it is building railroads at great national expense and operating them The need of pure water for locomotive use as well as for other purposes has thus been made critically evident,

and the Minister of Public Works, Senor Ramos Nexia, has adopted a plan for making surveys for the determination of artesian water conditions along the lines of national railways. He contemplates topographical and geological surveys of a character similar to those executed by the U. S. Geological Survey, from which he derived the initial suggestion. He last summer applied to the U. S. government for the services of a geologist and such assistants as he might need, and our government has responded cordially to that request. Mr. Bailey Willis has accordingly entered into a contract for the term of two years, to execute topographical and geological surveys for the specific purpose of ascertaining artesian water possibilities in those districts which the minister may designate. With him are associated Mr. Chester W. Washburne, of the U. S. Survey, Mr. J. R. Pemberton, of Stanford University, and Mr. Wellington D. Jones, of Chicago University, as geologists, and Mr. C. L. Nelson and Mr. W. B. Lewis, as topographers, and the party sails shortly for Argentina to enter upon the work. While these surveys have a specific purpose, their possibilities of usefulness in developing the natural resources and encouraging settlement in the regions surveyed will not be overlooked, and the work will be founded on these scientific studies, upon which alone practical conclusions can safely rest. Thus it is hoped that a definite contribution to knowledge in geography and geology may be made.

It is desirable to point out that the Argentine government has a geological survey which has been in existence since 1903 in its present organization and which dates back half a century as a bureau of mines. It is under the direction of Senor E. M. Hermitte, who is assisted by Messrs. Bodenbender, Keidel and Schiller, three German geologists who have done excellent stratigraphic and paleontologic work, particularly in districts of the central Argentine Andes. They have unfortunately not been supplied with maps. The established Bureau of Mines, Geology and Hydrology is under the minister of agriculture. The surveys which are about to be made are undertaken by the minister of public works. The two operations are thus officially distinct, but it is hoped and anticipated that they may be mutually helpful.

THE ENGINEERING BUILDING OF THE UNIVERSITY OF CINCINNATI

The new $300,000 engineering building, and the new $150,000 power plant of the University of Cincinnati are rapidly nearing completion. The engineering building is of reenforced concrete and stone, four stories in height, built to accommodate five hundred students, and inasmuch as the greater number will be cooperative students, the building will accommodate one thousand.

Among the main features of the building will be a large laboratory 200 × 40 feet in size. This laboratory will be surrounded by balconies, which will give a much larger floor space than is indicated by the dimensions of the room itself. In addition to this there will be a large general club room for the students taking the regular engineering courses. There will also be a large consulting library, solely for the use of the College of Engineering.

The building will be fire-proof throughout and of the best possible construction. One marked feature of the building will be the absence of a great mass of heavy machinery which is usually found in engineering colleges. The students will possess the unique advantage of having at their disposal the use of the latest and most improved machinery in all of the different manufacturing industries having plants in the city of Cincinnati. They will gain their knowledge of the different operative processes at first hand in the great manufacturing establishments, for which Cincinnati is famous. This condition has permitted the use of space which would have otherwise been occupied by machinery for extensive scientific and research laboratories.

The power plant is one of the most extensive and thoroughly equipped in the country, and has been built to meet the needs of a growing university for many years to come. It will supply heat, light and power for all of the different buildings of the university.

One marked departure from the customary arrangement of university buildings will be

found in the class-room facilities in the new engineering building. Inasmuch as the building has been erected mainly for the use of the rapidly enlarging cooperative department, it was felt by Dean Schneider that the old arrangement of class rooms was inadequate to meet the needs of the mature men who constitute a large proportion of the university student body These men come from the various shops and large establishments of the city to the college, and in their daily experience in actual productive work, they have been confronted by many problems, not alone of theory, but of practise, and these problems have suggested to them certain very definite questions which they bring from the shops to the college for answer by their instructors It was felt that a change in the ordinary class-room work and arrangement was needed to meet these new conditions Each section will have a room which will be wholly its own. This room will be furnished with a table 5×10 feet, comfortable chairs, drawing tables, drawer lockers and magazine racks Each group will have one such room, which will serve the dual purpose of club and class room.

The purpose will be to make these rooms not only places for recitation and instruction, but also sub-social centers They will contain everything needed to satisfy the social needs of each section, and during the time when classes are actually being conducted in this room, the teacher and the men in the class room will sit around the large table and the practical and theoretical questions which the students have asked will be discussed in open session This is a marked innovation in interior college arrangements, but the whole plan of the engineering college is being evolved to meet the special needs of the cooperative system, and any change whatsoever which promises to more satisfactorily meet the needs of a student body such as will occupy this building, will be thoroughly tried out before its adoption or final rejection.

THE INTERNATIONAL SCHOOL OF AMERICAN ARCHEOLOGY AND ETHNOLOGY

THE International School of American Archeology and Ethnology was inaugurated in the City of Mexico on January 20 The founding patrons of the school are the government of the United States of Mexico, the government of Prussia, Columbia University and Harvard University. The University of Mexico has placed at the disposal of the school rooms in which classes may be held, and will facilitate access to libraries, museums, institutes and other scientific centers in which are pursued studies like those of the school, and will aid in the support of the school with an annual subsidy of $6,000 Each patron will in turn appoint and pay a director of the school, and will also allot fellowships which will be sufficient to cover the expenses of board and lodging and transportation of a fellow In accordance with the statutes the government of Prussia has appointed as director Professor Eduard Seler, director of the section of anthropology and archeology in the Royal Museum at Berlin, who has already made extensive researches in Mexico He will hold office for one year, and will be aided by Professor Franz Boas, of Columbia, during his presence in Mexico as professor of anthropology at the National University Two appointments to fellowships have been made, Dr Werner Von Hárchelmann by Prussia, and Miss Isabel Ranives Castaneda by Columbia University

All the explorations and studies of the school are to be subject to the laws of the country in which the work is undertaken, and all objects found in investigations or explorations will become the property of the national museum of the country in which the studies are carried out In case similar specimens of the same kind of object are discovered duplicates will be given to the patrons who supply the necessary funds for the exploration Most of the explorations will be conducted in the rich fields of Mexico, and the government of that country has already given the necessary authorization for the investigations which will soon be begun and are certain to produce interesting and valuable results.

SCIENTIFIC NOTES AND NEWS

SIR JOSEPH LARMOR, Lucasian professor of mathematics at Cambridge University and

secretary of the Royal Society, has accepted an invitation to become the unionist candidate for the vacancy in the parliamentary representation of Cambridge University.

The Belgian Royal Academy of Sciences, Letters and Arts has awarded to Dr. L. A. Bauer, of the Carnegie Institution, the Charles Lagrange Prize for the period of 1905–08, of 1,200 francs, on account of his various researches in terrestrial magnetism.

Dr. Hideyo Noguchi, associate member of the Rockefeller Institute for Medical Research, received in December, 1910, from the Japanese government the honorary title of Professor (Igakuhakushi).

Professor Jacques Hadamard, of the Collège de France, has accepted an invitation from Columbia University to give instruction in mathematics at Columbia for a period of four to five weeks in the autumn of 1911. He will conduct one course in pure mathematics and one in mathematical physics.

It is reported that the Krupp Society has given Professor Emil Wiechert, of the University of Gottingen, 10,000 Marks to enable him to conduct experiments in aerodynamics, and also 6,000 Marks to Professor Leopold Ambronn, of the same university, for the construction of a new photographic apparatus.

The American Philosophical Society at a recent meeting appointed a committee to memorialize congress with a view to founding a National Earthquake Laboratory at Washington. This committee consists of Dr. Charles D. Walcott, secretary of the Smithsonian Institution, chairman; Professor H. F. Reid, Johns Hopkins University; Professor William H. Hobbs, University of Michigan; Dr. R. A. F. Penrose, Philadelphia, and Professor T. C. Chamberlin, University of Chicago.

It is announced that Baron Reinach has provided the Frankfort Physical Society with the funds necessary to establish a seismological observatory on the Feldberg, in the Taunus range. Dr. F. Linke will be the director of the observatory.

Professor F. Smith and Mr. F. A. Loew, of the University of Illinois, will this summer be associated with Professor J. E. Reighard at the Biological Station of the University of Michigan at Douglass Lake.

C. L. de Muralt, recently appointed professor of electrical engineering at the University of Michigan, becomes editor of the *Railway Electrical Engineer*. This journal is the official organ of the Association of Railway Electrical Engineers.

Dr. J. J. Davis, of Racine, Wis., who has devoted a large amount of time to the study and collection of parasitic fungus flora of Wisconsin, has been appointed curator of the herbarium of the University of Wisconsin. On their transfer to the new biological building, the botanical collections will be provided with new and better quarters for work, and a complete reorganization of the museum is planned.

Fourteen Harvard professors will be absent during the second half of the current academic year. They include Professors C. L. Jackson, of the chemistry department; Hugo Munsterberg, of the philosophy department, who is serving as exchange professor at the University of Berlin; J. L. Love, of the mathematics department; C. L. Bouton, of the mathematics department; W. Z. Ripley, of the department of economics; R. B. Dixon, of the division of anthropology, and C. R. Sanger, of the chemistry department.

The following officers were elected at the recent annual meeting of the Royal Meteorological Society: *President*, Dr. H. N. Dickson; *vice-presidents*, F. Druce, H. Mellish, R. G. K. Lemfert, Colonel H. E. Rawson, C.B.; *treasurer*, Dr. C. Theodore Williams; *secretaries*, F. C. Bayard, Commander W. F. Caborne, C.B.; *foreign secretary*, Dr. R. H. Scott, F.R.S.

The Nashville section of the American Chemical Society held its organization meeting at Furman Hall, Vanderbilt University, on January 25. After the adoption of a constitution the following officers were elected: *chairman*, W. L. Dudley; *vice-chairman*, J. I.

D Hinds, *councillor*, R. W. Balcom, *secretary and treasurer*, L J Desha. Dr W. L Dudley gave an informal talk on the "Action of Wireless Waves on Rarefied Gases" The regular meetings of the section will be held on the third Friday of each month

Dr H W. Wiley, chief chemist of the Department of Agriculture, Washington, D. C, delivered an address at Syracuse University on February 1 upon "The Services of Chemistry to the Public Welfare" The meeting was held in the Bowne Hall of chemistry under the joint auspices of the Syracuse Chapter of Sigma Xi and the Syracuse Section of the American Chemical Society

Professor C K Leith, of the University of Wisconsin, gave a lecture before the advanced students in geology at Northwestern University on January 26 His subject was a comparison of the origins of the iron ores of the Lake Superior region, of Cuba and of Brazil

A lecture on electric oscillations and their application to wireless telephony was delivered before the chapter of Sigma Xi at Purdue University, LaFayette, Ind, January 28, by Professor C M Smith, of the department of physics of that university Professor Smith explained the theory of wireless telegraphy and telephony and pointed out the entirely different conditions necessary for wireless telephony as compared with wireless telegraphy The lecture was illustrated by a large number of experiments showing the analogy between electric and sound waves and was concluded with a demonstration of the singing arc lamp which reproduced very clearly a band selection through the agency of a phonograph and microphone located in a distant room

At a meeting of the Royal Geographical Society on January 16 Dr Johan Hjort gave a detailed account of the Michael Sars North Atlantic deep-sea expedition of 1910, which he, with Professor H. H. Gran, Dr. Helland-Hansen, Mr. E Koefoed and Captain Thor Iversen, undertook at the suggestion and at the expense of Sir John Murray, who himself accompanied them

Dr. Hans Grether, of Karlsruhe, Germany, has been appointed a special lecturer in McGill University and is giving in the graduate school, during the present session, a course of advanced instruction in the "Computation of secondary stresses in bridge trusses and other framed structures" The following gentlemen will act as special lecturers in the course on economic geology at McGill University during the present session R. W Brock, Esq, M A, director of the Geological Survey of Canada, Dr J D Irving, professor of economic geology, Yale University, and O E LeRoy, Esq, M Sc, of the Geological Survey of Canada

A state Biological Survey has been organized at the University of Colorado, the work being in the hands of a committee consisting of Professors F Ramaley, T D A Cockerell and J Henderson The work of such a survey has been carried on for a number of years past, but until now there has been no definite organization The work includes fossil as well as living species of plants and animals

The British Treasury has, on the recommendation of the development commissioners, made a grant to the Board of Agriculture and Fisheries from the development fund of £40,000 for the ensuing year for the encouragement of light horse-breeding in Great Britain

The third semi-annual meeting of the American Institute of Chemical Engineers will be held at Chicago, Ill, June 21 to 24 Arrangements will be made to visit a number of the large technical plants in the vicinity The committee on chemical engineering education and standardization of boiler tests will have important reports to present The program of papers will be announced later

The first Universal Congress of Races will be held in London from July 26 to 29, 1911, to discuss the general relations between western and eastern peoples.

A course of nine public lectures on problems of psychology have been given at Columbia University, as follows·

January 31—"Traits of Dreams," Professor C. E. Seashore, University of Iowa.

February 1—"Social Psychology," Professor Charles H. Judd, University of Chicago

February 2—"Memory and Imagination," Professor E. B. Titchener, Cornell University

February 3—"Frailties of Imageless Thought," Professor J. R. Angell, University of Chicago

February 4—"The Standpoint and Scope of Social Psychology," Professor Mary Whiton Calkins, Wellesley College

February 6—"The Psychology of Dream States," Professor Joseph Jastrow, University of Wisconsin

February 7—"The Rôle of the Type in Simple Mental Processes," Professor W. B. Pillsbury, University of Michigan

February 8—"The Ontological Problem of Psychology," Professor George T. Ladd, Yale University

February 9—"Some Psychological Topics Emphasized by Pragmatism," Professor Josiah Royce, Harvard University

The new Oceanographic Institute, which Prince Albert of Monaco has erected on a part of the site of the old convent of the Dames de Saint-Michel in the Rue Saint-Jacques, was formally inaugurated on January 23. We learn from the London *Times* that the opening ceremony was performed by Prince Albert in the presence of President Fallières, M. Emile Loubet, members of the government and the principal dignitaries of the university and city of Paris. In his inaugural address Prince Albert explained the motives which had prompted the foundation of the new Institute in Paris and the purpose which he had designed it to fulfil as the complement of the Oceanographic Museum that he had founded at Monaco last year. The minister of public instruction, on behalf of the government, the president of the Academy of Sciences, on behalf of the French Institute, and the vice-rector of the university each returned thanks to Prince Albert for his munificent foundation. The new institute is at once French and international in character. This latter aspect of the foundation is marked by the presence on the committee of Sir John Murray, Professor Buchanan, Professor von Drygalski, Dr. Nansen and other foreign men of science. In addition there is an administrative council composed of French men of science. The institute is designed to work in intimate cooperation with the museum at Monaco, where laboratory work will be conducted, while in Paris lectures on the principles of oceanography will be delivered.

The following resolutions favoring a federal grant to elementary and secondary education were passed unanimously by the house of representatives of the Illinois legislature on January 18.

Whereas, The legislature of Illinois by the joint resolution of February 8, 1853, was the first among American legislatures to petition the congress of the United States to make a grant of public land for each state in the union for the liberal endowment of a system of industrial universities, one in each state, to promote the more liberal and practical education of our industrial classes and their teachers; and,

Whereas, The congress not only made a liberal grant of land in the year 1862 for this purpose but has also followed up this policy once begun by still more liberal appropriations for the support of higher education in agriculture and the mechanic arts, resulting in the great chain of colleges for agriculture and the mechanic arts to be found in every state and territory in the union, and,

Whereas, The time has now come for the adoption of a similar policy in the field of elementary and secondary education therefore, be it

Resolved, by the house of representatives of the state of Illinois, the senate concurring herein, That the congress of the United States be respectfully petitioned to appropriate annually to each state and territory in the union a sum equal to one dollar per head of the population of said state or territory as ascertained by the last census, for the purpose of establishing, maintaining and extending in the elementary and secondary schools of said states and territories, while not excluding other elementary and secondary subjects, such practical, industrial and vocational training, including agriculture, the mechanic arts, domestic science, manual training, commercial subjects and such instruction in other similar subjects of a practical nature as the interests of the community may seem to demand; and

Resolved further, That our senators in congress be instructed and our representatives be requested to use their best exertions to procure the passage of a law of congress donating said sum to each

state and territory in the Union for said purpose; and

Resolved further, That the governor of this state is hereby requested to forward a copy of the foregoing resolutions to our senators and representatives in congress and to the executives and legislatures of each of the other states and territories, inviting them to cooperate with us in this meritorious enterprise

ACCORDING to a statement by Mr. Ray Priestley published in the papers before the departure of the *Terra Nova* for the Antarctic, an important geological discovery was made during Sir Ernest Shackleton's expedition Mr. Priestley, who is now engaged with Captain Scott's Antarctic expedition, and who had for some months been collaborating with Professor David at Sydney in arranging a memoir of the geological work of Sir Ernest Shackleton's expedition, states that he discovered a small piece of rock on the Beardmore Glacier which now upon full examination proves to belong to the Cambrian limestones It appears that a similar formation has in recent years been discovered in South Australia by Mr Griffith Taylor, who is also a member of Captain Scott's scientific staff The fossils found both in the latter and in the Antarctic specimens are identical, and the inference is that at a not very distant past the Antarctic was united to the continent of Australia The fossils referred to are the immediate predecessors of corals and sponges

UNIVERSITY AND EDUCATIONAL NEWS

A GIFT of $300,000 by Mrs. Russell Sage to Cornell University is announced. The money is to be used for a new dormitory for women students, to be known as the "Prudence Risley Hall" in honor of Mrs. Sage's mother.

THE old Philadelphia Dental College at Eleventh and Clinton Streets, which was purchased several months ago by Jefferson Medical College for $45,000, after remodeling will become the Daniel Baugh Institute of Anatomy.

AN increase in the income and in the building fund of the University of Wisconsin on the basis of a growth of 25 per cent. in the number of students in the last two years and of the constantly growing demand on the part of the people of the state for expert assistance from the university, is provided for in a bill introduced in the state legislature It provides for changing the present two sevenths of a mill tax on the assessed valuation of all property of the state for maintaining the university to three eighths of a mill. This will increase the general university income approximately from $750,000 a year to $1,000,000 a year For new academic buildings and permanent improvements the proposed legislation appropriates $300,000 a year, of which $50,000 annually is set aside for the purchase of books, furniture, apparatus and equipment. The remaining $250,000 a year is to be used for the construction of academic buildings, in the order of their greatest need and for the enlargement and repair of present buildings. For the construction and equipment of women's and men's dormitories the university bill provides for an annual appropriation for four years of $250,000 Out of this $1,000,000 a woman's dormitory is to be built first, then a commons and union for men, and finally dormitories for men. The university extension would have $100,000 next year and $125,000 the following year. This is an increase of $50,000 a year over the present appropriation. For agricultural extension, including traveling schools of agriculture and lectures and demonstrations throughout the state, $40,000 is provided, an increase of $10,000 over the present amount

THE regents of the University of Michigan have applied to the legislature for a grant of $250,000 for a science building The need for more adequate accommodations for the natural sciences has been felt for a number of years, and was the subject of a memorial to the regents, by the departments of botany, zoology, geology, mineralogy and forestry, in 1907. The congestion of that time has steadily become worse with the increase of students, and only slight possibility of expansion with present buildings In 1908 the faculty of the entire literary department unanimously adopted a resolution to the effect "that in the opinion of this faculty, the greatest present

need in the material equipment of the department of literature, science and the arts is a new building for the natural sciences."

DISCUSSION AND CORRESPONDENCE

UNIVERSITY FELLOWSHIPS

After reading the address of Dr. Jordan recently published in Science, I desire to enter a protest against some of his statements. I have been for many years in touch with graduate students, and have been moved with a keen desire to induce them to enter the teaching profession. I thus know of the difficulties they face and why many of them fail to fulfill the hopes I had in them. I agree with Dr. Jordan that we are not producing the scholars we should, but in the diagnosis of evils we differ. In his address he comes back again and again to the fellowship system and talks touchingly of the starving doctor of philosophy. In my opinion, the starving doctor is a figment of the imagination. It is the rapidity of promotion, not the lack of it, that ruins promising investigators.

The University of Pennsylvania has had a system of fellowship long enough to make its effects apparent. Twenty-four Harrison fellowships have been granted annually for fifteen years. Few of the fellows were, however, graduates of Pennsylvania. The effect of this will be apparent when it is recognized that from the fellows instructors are chosen and from them in turn the professors come. Practically all the instructors and younger professors are graduates of other colleges. Our young men are a cosmopolitan body representing nearly every college and university in the country. The result has been a transformation of the university in a deeper and more vital way than any other of our important changes. Besides these fellows who have become teachers there has been another group coming from the smaller colleges where they were instructors and who have returned to them after a couple years' study here. These two groups account for nearly all our former fellows.

The following table gives the present occupation of all who have been fellows.

Professors and instructors in universities and colleges	107
Normal and secondary teachers	31
Literary work	5
Business and business experts	8
Government experts	6
Chemical experts	4
Social work	7
Ministers	5
Students	10
Deceased	8
Unknown	2
Total	193

This does not look like starvation. If we had double the number of fellowships we could double the service we render to our own and to sister institutions without overstocking the market. The fact is a good instructor pays his way everywhere. It is the professor that needs endowment.

Where then is the trouble if it is not in this quarter? Here again I shall turn to my own experience, which, however, I believe is that of many others. I find among the fellows a man of promise. He is made assistant at $800 a year, then instructor at $1,000, which is steadily increased until at thirty he is earning $1,500. Now comes the test under which so many break down. He has published a thesis, written several articles, and has become a proficient teacher. This makes him a man of the kind that college presidents want and friends praise. It is one of the peculiarities of college presidents that they want "men of promise," they never seek for "men of deeds." This young man should settle down on his $1,500 a year and do work that would advance his science. But the attractions of salary and the flattery of friends are too much for him. He drops his original work for more pay and finds that hastily constructed books help him along more rapidly than original work. This is the last of him so far as science is concerned. Let me give a couple examples. A young instructor was pushed along until he had the $1,500 a year. He then received an offer of $2,500 from another college. I talked to him in this way: "You are familiar with the courses you give and your hours are reasonable. Now is the

time to use your leisure to do original work The next five years will settle what your scientific standing will be See that you make good I can not get for you an increase of salary, but I can get for you every facility for good work" I thought I had my man, but he came to me a couple days later saying he had decided to go, as his wife thought she could not live on $1,500 a year As a second case I take that of a young man in another institution in whose work I became interested When a book of his appeared, I wrote him that I was sorry he printed it It did not fulfil the expectations I had of him, and I believed no man could afford to be the author of a useless book He replied that he was glad others were not of my opinion and sent with the letter several laudatory clippings from papers and eulogistic letters from professors with reputation This, of course, was a great victory and in a way I admit he was right, for the book brought him a call to a leading university. But a book of promise is yet to come This, not starvation, is the road to ruin Young men are not spoiled as fellows, but as assistant professors A call means new responsibilities, the breaking up of old habits and a loss of self-discipline The new president calls him a second Agassiz, the university press bureau spreads laudatory notices of him in the local press and the alumni take a hand in extension of the fame of the new genius

Dr Jordan tells us that he has been working for others the greater part of his life and that he is disappointed in the results. But for whom has he been working—for fellows or for assistant professors? There are no fellowships at Stanford University. If he would go over his cases, he would, in my opinion, find that he, like other college presidents, has been dragging into the lime light young men that it would have been better to have let alone Each university should build up its faculty quietly from its fellows instead of running press bureaus to laud immature men Scholars are not born, they are made by their environment

No one is worth keeping who will not halt long enough on $1,500 a year to do good work The assistant professorship is an unearned entrance to the halls of learning. If faculties would agree that no one should have the title of professor until it was fully earned, the increase of true learning would be possible Scholarship is made by hard work, and comes only with gray hairs If a man is wanted from another university take its best. Young men should be left alone until they are fully developed before transplanting them.

S N Patten

University of Pennsylvania

To the Editor of Science: In response to a recent friendly note from Dr Edmund B Wilson let me say No money could be better spent than that used for the fellowship which enabled Wilson to walk and work with Brooks and Martin and Remsen But too much such money is used to hire mediocrity to make diagrams for pedantry

Our scholars must in some degree be descended from scholars Relatively few of our teachers have the personality which befits the leader in an intellectual school The scholar should be free to seek such leadership, and our present fellowship machinery tends, on the whole, to confuse rather than to help

David Starr Jordan

THE ARIZONA PASSENGER PIGEONS

The passenger pigeon is now generally believed to be extinct in a wild state, and of those formerly living in confinement only a single survivor, in the Zoological Garden at Cincinnati, remains Under these circumstances reminiscences of its past history naturally find place in ornithological and other journals, based on the recollections of observers still living or gleaned from the published narratives of early travelers and explorers of the birds' former range, some fifty pages of such matter having appeared in the last two numbers of *The Auk* alone Among recent contributions to passenger pigeon lore is Dr McGee's "Notes on the Passenger Pigeon," published in a recent number of Science[1]

[1] Vol XXXII, pp 958–964, December 30, 1910

Dr. McGee's paper is divided into two parts, the first giving his recollections of the great abundance and habits of the passenger pigeon as seen by him in eastern Iowa nearly half a century ago, the other an account of birds supposed to be passenger pigeons seen in arid southwestern Arizona as recently as 1905. His account of the abundance of these birds during the spring migration in eastern Iowa "in the sixties and early seventies" of the last century is a fact of great interest and is in accord with what is known to have occurred in the eighteenth and the early part of the nineteenth centuries in states further to the eastward. But the habits of the Iowa pigeons, as here detailed, during the breeding season and until and during the fall migration, are wonderfully suggestive of the habits of the mourning dove, and depart considerably from the habits of the passenger pigeon as observed and repeatedly recorded at points further eastward, as, *e g*, their laying two white eggs, living in family groups during and after the breeding season, and in this manner taking their departure southward at the approach of winter

The second or Arizona part of the paper is entirely contrary to our previous knowledge of the distribution of the species, and especially contrary to everything known of its breeding area It has not heretofore been recorded as occurring west of the eastern border of the plains, while its known breeding area was the transition zone of the east. To enable a bird with these geographical and physiological restrictions to pass the hot season and rear its young in the subtropical Lower Sonoran zone of southwestern Arizona implies a most wonderful range of adaptability, and one quite unparalleled in our present knowledge of bird life Not that some species of birds, the mourning dove among others, do not have breeding ranges that cover the greater part of North America, and seem equally at home, even in the breeding season, in regions as unlike as the humid wooded districts of the eastern states and the arid southwest, but there are others, like the passenger pigeon, which are restricted to a particular type of country, especially during the breeding season. From their known distribution, habits and food requirements, one would almost as soon expect to find a colony of ptarmigan, an alpine or semi-arctic bird, in Florida as passenger pigeons in the arid, almost forestless Lower Sonoran zone of southwestern Arizona. The passenger pigeon occupied the wooded districts of eastern North America, breeding from eastern Kansas, northern Mississippi, Tennessee, Pennsylvania and New York northward to western Mackenzie, central Keewatin, central Quebec and Nova Scotia, and usually in large colonies, it being at all times preeminently gregarious. If formerly found west of the great plains, it is very strange that none of the scores of ornithologists who have either lived for many years in the general region of Arizona and New Mexico or have during the last two or three decades thoroughly explored it in all parts, down to and along the Mexican border, have ever collected a specimen anywhere in this whole area that has been identified by a competent ornithologist as a passenger pigeon Again, Dr McGee's account of the nesting and other habits of the birds he took to be passenger pigeons at Tinajas Altas in Arizona are not incompatible with those of the mourning dove, its little brother, known to be of common occurrence in just the situations described Furthermore, the bird there known as the "Sonora pigeon," and referred to by Dr. McGee as "seen singly and by twos and threes, either distant or in flight," and "noted as resembling the passenger pigeon," is the white-winged pigeon (*Melopelia asiatica*, formerly *M. leucoptera*) "The Sonora pigeon (at least the bird observed at Tinajas Altas) differs so widely as to be readily distinguishable from the mourning dove," and of course also from the passenger pigeon. It is extremely to be regretted that "unexpectedly hasty abandonment of the camp unfortunately prevented preservation of skins of the birds," for while no one will doubt the author's sincerity and conscientiousness in placing on record his recollections of these birds, it is certain that ornithologists will desire more

substantial evidence of so improbable an occurrence as the breeding of the passenger pigeon in arid southwestern Arizona before they will be willing to accept these observations as a part of the history of a now practically extinct species If specimens of the birds in question had been obtained and identified by competent authority, it would doubtless have saved burdening the literature of the wild pigeon with another questionable record, and one that may prove extremely difficult to eliminate.

J. A. ALLEN

ON THE TRANSFERENCE OF NAMES IN ZOOLOGY

As the preparation of an official list of *nomina conservanda* is now under consideration by the International Commission on Zoological Nomenclature it may not be out of place to call attention to a point that seems to me of prime importance in this connection, although it has received little notice from recent writers on nomenclatorial reform

It is simply this—while the rejection and replacement of familiar names for well-known animals is, of course, an inconvenience to zoologists, it is a trivial matter in comparison with the grave possibility of confusion that arises when the names are used in an altered sense In the former case we merely multiply synonyms, and, unfortunately, they are so numerous already that a few more hardly matter; in the latter case there is a real and serious danger of ambiguity. Thus, at present, a writer who mentions *Trichechus* may be referring either to the Walrus or the Manatee, *Simia* may mean either the Orang or the Chimpanzee, *Cynocephalus* may be either a "flying Lemur" or a Baboon, and so on through all the great groups of the animal kingdom till we come to *Holothuria* which may refer either to a sea-cucumber or to a Portuguese man-of-war. Cases like these seem to me to be on an entirely different plane, as regards practical importance, from those in which an old name is simply rejected; even if the shore-crab is to be called *Carcinides* for the future we have only the additional burden of remembering that it was once called *Carcinus*.

A striking (if somewhat exceptional) instance of the pitfalls that are in preparation for future students is found in the section on Crustacea in Bronn's Thierreich (Bd V., Abth ii) On p 1056 there is an allusion to "*Astacus*" and on the following page to "*Astacus* (= Homarus)." In the bound volume (unless the part-wrappers have been kept in place) there is nothing to show that a change of authorship intervened between these two pages and that, while the second "*Astacus*" refers to the lobster, the first indicates the crayfish

If the International Commission could be persuaded to consider first those names that are threatened with *transference*, before proceeding to deal with those that are merely in danger of *replacement*, they would, I believe, secure the support and cooperation of many zoologists who have doubts as to the practicability of the schemes lately put forward.

W. T. CALMAN

BRITISH MUSEUM (NATURAL HISTORY),
CROMWELL ROAD,
LONDON S W,
January 23, 1911

SCIENTIFIC BOOKS

African Mimetic Butterflies. By H ELTRINGHAM Oxford, Clarendon Press. 1910.

The remarkable resemblances often observed between insects of different genera, families or even orders, have long attracted the attention of naturalists. In some, probably many, cases the explanation may be found in parallel variation, or similar conditions of life. Such explanations do not go far into the heart of the matter, but they are satisfying to those who like to give a "reason" for everything. Bates, who was so familiar with the insect-fauna of the Amazons, hit upon a more special "reason" for resemblances observed by him. This was, in short, that certain species which were edible simulated others which were distasteful and so gained protection. The subject was taken up by Wallace and other naturalists, and soon a large body of evidence was available, especially in relation to butterflies. It was proved to be a fact that certain

forms were disliked by birds and other natural enemies, it was shown that young birds did not instinctively reject these insects, but that after having tried and found them nauseous, they avoided them subsequently. It was then not difficult to see that if an edible species came to sufficiently resemble an inedible one it would be often taken for it and so escape. At this point it was observed that sometimes there were two or more butterflies very much alike, but all inedible. Fritz Muller pointed out that there would be gain in this, since the experience obtained in tasting one might suffice to cause a bird to reject all subsequently, whereas if they were all alike, each would separately have to pay its tribute to inexperience. Thus there were recognized two sorts of "mimicry," called the *Batesian* and *Mullerian*, respectively.

Examples of these phenomena have especially been observed in the tropics, where substantially the same conditions have existed for long ages, and living things have had time to develop some very nice adjustments and interrelations. In the volume just issued, Mr. Eltringham has taken up the mimetic butterflies of Africa, and has covered the ground so well that any reader may gain a good knowledge of the main facts without access to a collection of African specimens. There are given no less than 176 excellent colored figures illustrating the different species, varieties and sexes, while in the text each one is discussed at some length. There are also sufficient bibliographical references. In addition to the matter indicated by the title, there is a good general discussion of the whole subject of mimicry, and a summary of the evidence relating to natural enemies. Thus Mr. Eltringham's book may well serve as a guide to those taking up the subject and will be found useful in biological departments of universities, where "mimicry" is discussed along with other biological theories.

A special chapter is devoted to objections to the theory of mimicry, but those wishing to see the strongest adverse arguments should consult Professor R. C. Punnett's paper on mimicry in Ceylon butterflies, recently (September, 1910) published in *Spolia Zeylanica*, Vol. VII. Professor Punnett spent two months in Ceylon investigating some well-known cases, and came to the conclusion (or fortified a conclusion previously reached?) that the phenomena should be explained in quite another manner. Professor Punnett, like Mr. Eltringham, gives us admirable colored figures, and his discussion is most interesting. Some of the points brought forward are the following: (1) In Ceylon birds seem not to be serious enemies of butterflies. The chief enemies are apparently lizards and Asilid flies, and these appear to lack discrimination. (Experiments with a lizard were made.) (2) In various specified cases, the "model" and "mimic" do not occupy the same area to any extent, or the "model" is scarce when the "mimic" is common, a condition irreconcilable with the Batesian theory. (3) The resemblance is often imperfect, and when the flight of the insect is different it seems unlikely that they should be confused.

Against evidence of this sort may be placed the abundant data of Wallace, Marshall, Trimen and others, who have spent long years in the tropics, instead of a short two months. It may be reasonably urged, however, that if in only a few cases it can be demonstrated that "mimicry" has a meaning quite different from that assigned by Bates and Muller, serious suspicion is thrown on the whole theory or group of theories. Professor Punnett, long associated with Professor Bateson, is of course well known as an ardent Mendelian, and it is not a surprise to find at the end of his paper a Mendelian interpretation of mimicry. As he states, breeding experiments are urgently required, but judging from the classic experiments of Doncaster on *Abraxas*, he formulates an hypothesis to account for the polymorphism of mimetic *Papilio* in Ceylon. We can not take the space here to copy his tables, but the results he gets appear to coincide with the facts. Incidentally he cites the case of *Colias edusa*, in which the pale *helice* form of female, crossed with a normal male (necessarily so, as *helice* occurs only in the female) gave females of

both *edusa* and *helice* types He remarks that the fact that *edusa* ♀ can come from *helice* appears to disagree with his hypothetical scheme, but he adds that the typical female differs from the male, and suggests that there *may* be or have been a possible "*a* type" of female resembling the male (such a type is well known in the *Papilio* under discussion) It is interesting to be able to state that the hypothetical "*a* type" of female *C edusa* is actually known, and may be found mentioned in *Entomologist*, 1889, p 26

I can not help thinking it probable that whether or not the precise Mendelian hypothesis offered by Professor Punnett is justified by subsequent research, the facts will be found to be very much as he has postulated I do not think, however, that the theory of mimicry is thereby contradicted According to the old view that all organisms are everywhere varying (aside from non-inherited environmental effects), and that natural selection is necessarily in continuous operation to keep them constant or to modify them as needed, it must be confessed that some of the observed facts are hard to interpret According to the newer view that "original variations" happen at relatively rare intervals, and that a stable type once produced may continue indefinitely if not discriminated against, the matter assumes a very different aspect Consider the great antiquity of insect genera, as shown by fossil remains; consider the kaleidoscopic changes in insect-type producing innumerable species often without material advance in the general type, with all this time and change there must have been produced many pairs of more or less unrelated species resembling one another When this resemblance has been advantageous it has been preserved, while other forms have died out, and hence to-day the proportion of such cases is vastly greater than we could expect from chance coincidence It is not necessary that everywhere and at all times mimicry should be functional, the evidence seems to show that it generally is, and that is sufficient Indeed, if a type has been preserved because of its ability to "throw" mimetic forms, it is likely enough to continue to do this, even in places where this is unnecessary

Those who are confronted by the vast array of insect species rarely think of the unseen gaps in the ranks These may perhaps be best appreciated by considering the fauna of the Hawaiian Islands, as elucidated by Sharp, Perkins and Walsingham Here we have large genera with multitudes of allied species, no doubt the result of the immigration in ancient times of single types of a few groups Comparatively free from the stress of competition these Hawaiian groups have, as it were, nearly their full membership, on continental areas only remnants usually remain

Thus I think that the newer work on heredity, read aright, only strengthens the theory of mimicry, by relieving it of a load it was ill-fitted to carry I do not see any other plausible way of accounting for the facts, unless it is by supposing that similar environments give rise to similar modifications of the germ-plasm This idea loses support when we remember the cases (*e g*, in butterflies and bees) in which the same superficial appearance is due to entirely different structures

It may still be debated whether natural selection has had much to do with the production of mimetic forms, in the sense of bringing about the *accumulation* of favorable variations For my own part, I can not doubt that this cumulative effect of selection is real, and is a necessary cause of the more striking and complex instances of mimetic resemblance The rarity of original variations, while great enough to relieve selection from the necessity of acting continuously on all characters, is doubtless not so great as to prevent it from bringing about many striking cumulative results, in the manner postulated by Darwinians

I have wandered too far away from Mr Eltingham's book, but I must return to it to mention his remarkable experiments with the larva of a moth, *Odontoptera bidentata* Larvæ fed on ivy were offered to a lizard, and found extremely distasteful They were, although of cryptic coloration, nearly always rejected by the reptile Several larvæ were then transferred to apple, and after feeding on this

plant for a few days were again offered to the lizard, which ate them readily. Thus it is shown that a mere change of food plant may be of great importance in relation to destruction by natural enemies; furthermore, that some distasteful larvæ do not possess "warning" coloration, and again, that these cryptically colored larvæ were not recognized, after a few days, as objectionable. It would be interesting to repeat the experiment, having, if possible, ornamented the larvæ in some way so that they would be more easily recognized.

T. D. A. COCKERELL

UNIVERSITY OF COLORADO

Sewage Disposal. By LEONARD P. KINNICUTT, Director of the Department of Chemistry, Worcester Polytechnic Institute; C.-E. A. WINSLOW, Assistant Professor of Biology and Biologist in charge of the Sewage Experiment Station of the Massachusetts Institute of Technology, and R. WINTHROP PRATT, Chief Engineer of the Ohio State Board of Health, late director of Sanitary Engineering of the Republic of Cuba. New York, John Wiley & Sons. Price, $3.

This octavo book of 421 pages consists of a well-blended recital of American and European, especially English, experiences which have established the principal features now recognized in the science and art of sewage disposal. Almost without exception it is free of views that are either radical or so old-fashioned as to be regarded as superseded.

The joint authorship of this book has much to commend it and it will be noted that it includes in Professor Kinnicutt one of the foremost sanitary chemists in America, and one who has been fortunate enough to make numerous inspection trips to sanitary works in Europe, during the past thirty years. Professor Winslow, formerly of the Institute of Technology, in Boston, now of the College of the City of New York, has had unusual opportunities of studying the biology of this subject, particularly in connection with extensive experiments made at Boston. The practical side, from an engineering standpoint, has occupied the attention of Mr. Pratt for many years, first in Massachusetts and later in Ohio, with a valuable experience in Cuba.

The chemical and biological aspects of the book are more comprehensive and detailed than those of an engineering nature. Probably this is wise in a book of this size on a subject of such a wide scope as this one and which is undergoing such rapid changes in some of the more important aspects of engineering practise. Numerous references are given to details of results obtained from the findings of the Royal Commission on Sewage Disposal of Great Britain, as well as the results of tests and practical operations in America and abroad, especially in England. References are rather meager as to German investigations and experiences. To some extent the same is true of the results of current practise in the design and operation of disposal works in the United States other than in Massachusetts and Ohio.

After an interestingly stated introduction as to the sanitary demand for sewerage and sewage disposal, the book is divided into thirteen chapters, of which brief mention may be made to advantage as follows:

Chapter 1, pp. 1–20, deals with the composition of sewage in the terms of the analyst. Chapter 2, pp. 21–44, outlines the disposal of sewage by dilution. Chapter 3 gives many details as to the screening and straining of sewage, pp. 45–67.

The preliminary treatment of sewage by sedimentation, chemical precipitation and septic process occupies Chapters 4, 5 and 6, pp. 68–166. These chapters are unusually well-written, although they do not bring fully up to date very recent developments with the so-called "Imhoff" tanks, which have shown themselves to be a marked step in advance during the past year or two in practical operations in western Germany.

The expensive, bothersome and frequently unsuccessfully solved question of the disposal of sewage sludge is well outlined on pages 167 to 192.

Chapters 8 to 11, inclusive, on pages 193–274, contain a well-balanced statement of ex-

periences in this country and abroad as regards filtration in intermittent sand filters, contact beds and trickling filters.

The remaining chapters, pp. 375–409, contain first a full statement of the recent work done in this country in the sterilization or disinfection of sewage, with data as to the efficiency and cost, while the book is concluded with a brief summary of the main features of sewage analysis with particular reference to those tests of most benefit in practical operations.

The book is very attractively written and is well indexed There are 113 figures illustrative of the various distinctive features of the principal processes. The more one studies the book the more apparent it is that there has been a vast amount of study given to the compilation of a wide fund of information so as to embody it compactly for convenient reference The book is free to an unusual extent of statements to which exceptions will be taken by experienced sanitarians. The principal points on which there would be differences in opinion are in reference to the residual quantity of dissolved oxygen which would be found in a stream into which sewage has been discharged, and the disparaging reference to automatic controlling devices for the operation of contact beds.

Taking the book as a whole, it may be safely said that it will be of much assistance in the class-room in teaching this subject to students and especially to the public hygienist desiring to get a general insight into the subject in its broader phases, with ample opportunity to ascertain where the various results with different styles of plants have accomplished definitely recorded results.

GEO W. FULLER

The Practise and Theory of the Injector. By STRICKLAND L. KNEASS Third edition, revised and enlarged. New York and London, John Wiley and Sons. 175 pages, 53 illustrations and diagrams.

This book possesses the great merit of having been written by one who is a master of his subject. It is no ordinary compilation; it is the reflection of a life work. Its author for more than a quarter of a century has given serious attention to the problem of perfecting the injector. He has made it a part of his business to study the fundamental principles underlying its action, to conduct experiments which would supply data with which to embellish the theory, and to contribute to the working out of actual designs which from time to time have become the standards of a great manufacturing company, yet such is his modesty that nothing which is printed suggests his personal activity in the development of the instruments he describes. The book presents in logical order the fascinating story of the development of the steam injector, an instrument which serves to feed water to a steam boiler through the action of a jet of steam drawn from the boiler which is fed. In the language of the book, "'its mode of action, extraordinary in appearance, contrary to that which we are in the habit of seeing or supposing, is explained by the simplest laws of mechanics and has been foreseen and calculated in advance'" The book is interesting throughout because its story is well told. It deals with a subject which can not be freed from mathematical theory, in a manner which is sufficiently complete to satisfy the most fastidious lover of equations, and yet the work is so admirably arranged that no one who is interested in the subject is likely to find difficulty in reading it

The introductory chapter on the early history of the development of the injector, from which the lines quoted above were taken, is chiefly a story of the achievements of Henri Jacques Giffard, who as early as 1850 had succeeded in developing the principles underlying the design of the present-day instrument. The injector, as a device for feeding boilers, was introduced into England in 1859, and into this country by William Sellers and Company the following year. The story of a demonstration of its action in England by one who had received a sample instrument from France is graphically told as follows:

I set to work at once, and by good luck coupled up the correct pipes to their proper flanges, but

was a great deal bothered what to do with the overflow flange. After a few nights' work I got my Injector fixed and got up steam, and to some extent began clumsily experimenting as the pressure rose to 60 pounds, the full working pressure of the boiler. I had the Injector fixed over a tank fed by a ball tap and closed by the boiler. I turned steam on and was staggered by the rush of water into the tank from the overflow pipe, and thought something was wrong. However, I continued to turn the steam spindle, and the escape from the overflow sensibly diminished until I could turn no further. In the meantime the ball tap started running furiously into the tank, showing me that water was going somewhere, and I knew it could go nowhere else but into the boiler. I then began to operate with the four thread screw at the side, and found that it adjusted the water supply, and succeeded in getting the overflow "dry." I then opened the peep-holes opposite the space between the combining and the receiving nozzles, and saw the white steam passing from one to the other on its way to the boiler. I then ceased operations, and had a pipe of tobacco,

The second chapter deals with the development of the principle of automatic regulation, by the adoption of which the injector was made to adjust itself automatically to conditions imposed by changes in steam pressure. The evolution of the various devices, which have been employed in the accomplishment of this function, is well set forth. Following this are several chapters dealing with the elements of design underlying each of the more important details of the injector, such as the delivery tube, the combining tube and the steam nozzle. These chapters, while constituting the more technical portion of the volume, are nevertheless so clearly expressed that the reader emerges from them with interest undiminished. A chapter entitled "The Action of the Injector" presents an analysis of the action of the entire instrument with numerical examples. It constitutes a basis for the design of such instruments, and it supplies the means for determining what are the limiting factors under conditions that may be prescribed or assumed. The longest chapter in the book, entitled "Applications of the Injector" presents excellent descriptions of the different well-known types of injectors now obtainable, with some discussion as to their adaptability to the requirements of different service. Another chapter discusses methods of determining the size of an injector and methods of testing, and presents data derived from tests. A chapter on the requirements of modern railway practise deals chiefly with matters affecting repairs and renewals, and a final chapter discusses certain problems which arise in practise, in connection with the use of injectors in locomotive service.

At a single point only does it appear that the author slips and this is when he discusses a detail in locomotive practise rather than one affecting injector design or operation, and when a book, as a whole, is strong and true, it is perhaps ungracious in the reviewer to call attention to half a dozen lines which are in no way essential to the purpose of the book and which constitute, in fact, no more than an unguarded suggestion. There are other relations, however, in which the statement becomes one of some importance, and consequently it should not go unchallenged. Under the head of "Feeding Locomotive Boilers," the author advises that "in approaching a station at which a short stop is made, especially between long and fast runs, it is advantageous to stop the injector a short time before the station is reached, to permit a slight checking of the fire, and then, when the station is reached, to feed the boilers quickly with one, or even with both injectors if necessary, to prevent blowing off at the safety-valve." The practise here outlined is one which has been often suggested and sometimes practised. It is, however, objectionable from several points of view, and as a practise should not be tolerated. The water in a locomotive boiler when the throttle is closed is in a quiescent state. Feed water entering under these conditions is not as rapidly mixed with the water already in the boiler as it is when the throttle is open and the process of ebullition is active. As a consequence the feed entering the boiler while the locomotive is stopped at a station, being comparatively cool, settles in the lower portions of the boiler,

where it cools the metallic parts with which it has contact, and by so doing induces strains which complicate the problem of boiler maintenance Moreover, a locomotive which is thus filled is not in good condition for the start, notwithstanding the fact that the gauge may show full working pressure, for at the start there is imposed upon the boiler the double task of supplying steam and of raising to the maximum temperature of the boiler the water which was fed into it during the stop The result is that the boiler pressure soon falls, and considerable time is required in which to restore it

F M GOSS

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SOIL PRODUCTIVITY

IN a discussion of the "Secular Maintenance of Soils" before the Geological Club of the University of Chicago on January 9, the undersigned expressed views as follows

That the era of soils began at an early but indeterminate period in the history of the earth, that the Proterozoic lands were probably mantled by soils and clothed with vegetation, that soils certainly prevailed on the land in the Paleozoic era, that sufficient soils and vegetation mantled the earth through all later eras to support the continuous evolution of land life, that the total eon of productive soils may be assigned a period of at least tens of millions of years, that therefore there must be some efficient natural process for the maintenance of soils

That the origin of the soil body lies chiefly in the granulation of rock; that soils are wasted at the surface by wind and wash, that wind and wash also distribute granules and mix soils and give to nearly all soils some of the essential soil constituents, that progressive granulation of rock adds soils below, that progressive solution removes soil matter from soils and from the rock beneath, that by these composite processes the body of the soil is at once enriched and impoverished; that so long as the *body* of the soil is maintained, any impoverished or anemic condition that may arise can be rectified; but if the *body* be lost, its restoration is tedious, laborious, or expensive

That the film-water that surrounds the granules of the soil when in a normal moist state is the specific soil water, that this is to be distinguished from the ground water that lies below the water-table, though these grade into one another, that the soil swells with the growth of the films in thickness, that there is an optimum of film-water when the soil is most swollen, that addition of water beyond the optimum destroys the surface tension of the films and leads to the shrinkage of the soils, the packing of the granules and to unproductivity,[1] that the solutions in the film-water are formed with facility because of the greatness of the surface contact relative to volume; that the concentrations of the solutions are controlled by the laws of equilibrium[2]

That the soil air is inversely proportional to the soil water approximately, that the soil air is to be distinguished from the earth's atmosphere, though grading into it and interchanging with it through diffusion and soil breathing, that, occupying the spaces between the film-coated granules of the soil, the soil air has great relative contact, that it acts at special advantage on both films and granules, that the union of minutely granulated earth, film-water under tension and interstitial air gives a combination of exceptional solvent and reactive power

That the soil is the home of minute life, plant and animal, that these intensify and modify the inorganic activities, that the forms of life are with little doubt more or less predatory and parasitic on one another, that these relations are probably in some cases pathogenic, and that these give rise to unsanitary states of the soil which affect its productivity, that progress is being made by Whitney and his associates in the discovery of toxic exudations that affect productivity, that plant societies are perhaps in part a result of mutually beneficial relations in respect to exudations and by-products, that the soil thus is little less than a world in itself, that its

[1] Cameron, *Journal Physical Chemistry*, 1910

[2] Cameron, *loc cit*

productivity is measured more by the efficiency of its complex of activities than by any mere measure of its inorganic constituents

That the capillary cycle, a sub-factor of the drainage cycle, is an important agency in maintaining the supply of potash and phosphorus in the soils, that the selective action of clays and of ferric oxides aid in a specific way the concentration of potash and phosphorus surfaceward, that at 592 localities in France analyses showed 68 per cent of the surface soils to be as high or higher in phosphoric acid than the subsoils, and 47 per cent. as high or higher in potassium than the subsoils, and similar facts are observed in America,[3] that the phosphate rocks in the sedimentary formations are largely *secondary concentrations*, that the formation of ferric and aluminic phosphates is a phase of concentrative action, that some of the phosphoric and potassic compounds are to be grouped with the silica and the aluminic and ferric oxides as the rock-elements that tend to stay in the soils, while the compounds of soda, lime and magnesia are more liable to go down to the sea, and the carbon and nitrogen to go off into the air, that these capillary and selective actions jointly are efficient factors in productivity, that Cameron's recent estimate[4] probably lies in the direction of the facts of the case, though confessedly only a tentative estimate based on elements not fully determined at present, viz, an annual drainage loss for the area of the United States of about 3,500,000 tons of potassium and 1,200,000 tons of phosphoric acid (PO_4), a possible crop-removal (reckoned at 1 ton per acre for the *entire* United States, carrying 1 per cent K, and 0 6 per cent PO_4) of 24,000,000 tons of K and 14,000,000 tons of PO_4, while, on the other hand, the capillary waters are carrying *toward* the surface 48,000,000 to 100,000,000 tons of K and 18,000,000 to 40,000,000 tons of PO_4.

That the plant-cycle cooperates with the capillary cycle in concentrating potash and phosphorus toward the surface by carrying these up into the plants whence they are deposited on the surface or in the soil, that the well-known rotation of legumes and cereals that enriches the soil in nitrogen may be supplemented by a *long-period rotation of trees and annuals* for the enrichment of the soil in potash and phosphorus

That the capillary cycle and the plant cycle conjointly contribute to a potash cycle and a phosphorus cycle by which these rise from the depths, pass into the plants, are shed as leaves, fruit and dead fiber on the surface—or pass through animals and are ultimately deposited on the surface—thence reenter the soil and are again taken up by plants, and so continue in the cycle until some intervening agency bears them out of it; that the length of this cycle is indeterminate and, in the absence of intervention, theoretically indefinite; that it is not, in the main, the *material substance* of the soil that is needed for food but *the energy* locked up in the grains, fruits, and so forth, by the anamorphic processes of the plants, that the real food comes chiefly from the sun and the material substance that temporarily embodies it is returnable to the soil indefinitely to be used again and again, that the really vital thing is the promotion of the cycle formed by plant anamorphism (solar energy going in) and animal katamorphism (solar energy coming out), that the contingencies of loss lie chiefly in the removal of the katamorphic products before they again enter into a new anamorphic process, contingencies that man emphasizes

That the SzeChuanese of West China, occupying a hilly sub-mountainous sandstone region whose area is less than that of Texas, a people numbering 68,724,800 according to the Chinese census, embracing more farmers probably than does the entire United States, have cultivated their soils continuously from an undetermined date before the beginning of the Christian era and quite without rock phosphates apparently, and yet have maintained a productivity exceeding, area for area, that of the virgin soils of America; that with little doubt this fertility can be maintained

[3] Bureau of Soils, U S Department of Agriculture.

[4] *Journal of Physical Chemistry*, 1910.

by the present mode of treatment until the country is base-leveled; that the SzeChuanese have thus demonstrated one mode of effective secular maintenance of the soil productivity, that their method is closely analogous to the natural method of the geologic ages; that a Chinese expert would criticize western practise as influenced unduly by prejudice respecting the use of the katamorphic products of human food-consumption.

That notwithstanding the loss due to this prejudice respecting the use of human katamorphic products, the soils of western nations generally show increases of productivity in the later years compared with the earlier, that, in particular, the data furnished by the Bureau of Statistics and the Bureau of Soils that the productivity of the soils of the United Kingdom, France, Belgium, Netherlands, Denmark, Germany, Austria, Hungary, Roumania and Russia show rather steady and notable increases in productivity for the last two or more decades that are covered by the statistics, that the lands most densely inhabited and most intensively cultivated, such as those of England, France, Germany and neighboring states, are more productive, unit for unit, than those of Russia, which are less densely occupied and less closely and persistently cultivated, that the old soils of Europe are more productive, unit for unit, than the newer soils of America; that in the United States the productivity of the last forty years shows general increase per acre, that the increase per acre in the older states, as the New York-New England group or the middle states, is more marked than in the southern or in the western groups, notwithstanding the larger proportion of virgin soil recently brought under cultivation in the last group; that while these and all similar statistics are subject to many qualifications in interpretation and application, they do not offer substantial grounds for an alarming forecast, applicable to an industrious and intelligent people willing to be guided either by oriental experience or by western scientific research.

T. C. CHAMBERLIN

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NOTES ON METEOROLOGY AND CLIMATOLOGY

THE effect of the recent construction of high buildings in New York City upon the United States Weather Bureau's records of wind velocity and direction for that city are discussed by Mr. E. S. Nichols, the local forecaster, in the October number of the *Monthly Weather Review*. Since the anemometer and the windvane were placed upon the American Surety Building at an altitude of 350 feet above the street in 1900, several new "sky-scrapers" have been erected in the immediate vicinity, vitiating to a greater or less extent the wind records since obtained. A comparison of the bureau's records with those of the New York Meteorological Observatory in Central Park, where the environment has not been greatly changed in forty years, shows that there has been a decrease of 16 per cent. in the hourly wind movement directly attributable to the recent construction. North winds have been affected the most, northeast and east have not been changed materially, while other directions have been considerably reduced. The number of days upon which gales have been recorded has decreased noticeably, and wind direction has been more or less deflected. Partly because of a desire to prevent the recurrence of such a condition in other cities, the bureau is gradually erecting appropriate buildings of its own in localities where future changes in the environment are not likely to affect the records obtained.

FROM an investigation of the relation between solar activity and terrestrial temperatures, Professor Humphreys has come to the conclusion that the decrease in the ultra-violet radiations received by the earth during the period of sun-spot maximum causes a similar decrease in the amount of ozone formed in the upper part of the earth's atmosphere. Moreover, since ozone allows the solar heat rays to penetrate it freely but absorbs most of the returning earth reflection, spot maxima indirectly produce diminished terrestrial temperatures. Abbot and Fowle had already concluded that spot maxima are accompanied by terrestrial temperature minima, and vice

versa, but had not recognized the significance of ozone in the sequence of events. The revival of scientific interest in ozone dates from 1904, when the late Professor Angstrom showed that a large amount of it existed in the upper atmosphere. As much may be gained from a further study, the chief of the Weather Bureau has urged the International Meteorological Committee to investigate the problem.

THE latest publication of the English Solar Physics Committee, "Southern Hemisphere Surface-air Circulation," was prepared by Dr. William J. S. Lockyer, secretary of the Solar Commission of the International Meteorological Committee. The work consists of a study of the mean monthly pressure amplitudes, the tracks of the cyclones and anticyclones and the meteorological records of several Antarctic expeditions. In an earlier memoir Dr. Lockyer pointed out the apparent similarity of the air movements over Australia, South Africa and South America, and suggested that anticyclones which crossed Australia were indications of a continuous state of things occurring in a belt encircling the earth. In the present memoir he shows the presence of such a belt in which movement is from west to east. The survey, which is an extensive one, doubtless will aid in the attempt to associate solar activity with the air movements of the southern hemisphere. Moreover, it also suggests that greater importance, from this point of view, must be attached to the meteorology of the polar regions than has hitherto been the case.

FROM a study of simultaneous records made at Corona, Colo., altitude 11,660 feet, and Denver, Colo., altitude 5,347 feet, distant in an air line about 38 miles, Professor A. J. Henry arrives at conclusions which briefly stated are as follows: (1) In general the temperature changes at high and low level stations are nearly synchronous, in point of time, and similarly directed. (2) Any abnormal course of the temperature between a mountain station and a near-by low-level station can generally be explained by considering the pressure distribution over the surrounding regions to a distance of at least 1,000 miles from the station. (3) An inversion of temperature between Corona and Denver occurs most frequently when the latter is under the influence of a Montana anticyclone while the former is affected by a cyclone to the west. (4) The high southwest and west winds occasionally observed on Pikes Peak and Corona indicate the early formation of a cyclone to the northwest or north. (5) In winter, mountain temperatures fall whenever a cyclone passes eastward across the mountains, or southeastward from Montana to Kansas. (6) The temporary presence of an anticyclone in the Great Basin affects the winds upon the mountains of central Colorado, giving high temperatures and fair weather. (7) The latter mountains cause a slight lowering of the pressure in an anticyclone as it passes over them.

ACCORDING to the Bulletin of the Mount Weather Observatory issued by the Weather Bureau October 31, 1910, during the three years in which regular free-air observations have been made the kite flights over 5,000 meters above sea-level number 31. Of these, three are over 7,000 meters, while in six of the flights the kites flew at a greater altitude above sea-level than has been attained elsewhere. The flight of 6,440 meters made April 5, 1910, at the Royal Aeronautical Observatory, Lindenberg, Germany, is the seventh highest above sea-level. In the opinion of Dr. William R. Blair, who has charge of the aerial work, the kite-flying apparatus has usually been the limiting factor at Mount Weather, and as this is gradually being improved, he expects that the kites will attain still greater heights. The upper air data are not only used by the forecasters in the central office in Washington, but it is hoped that when interpreted they will add to our knowledge of the atmosphere as a whole. Owing to the nearness of the ocean sounding balloons are not liberated on Mount Weather, but they have been sent up periodically from Indianapolis, Ind., Fort Omaha, Neb., and Huron, S. D. As these experiments have resulted in the acquirement of very desirable data, it is probable that they will be continued and perhaps extended during the present year.

A PRELIMINARY report of the investigation of the upper air in Java has recently been made by Dr. W van Bemmelen and Dr C Braak Aerological investigation at the Batavia observatory was begun under the auspices of the Dutch government in 1909 Because of the proximity of the sea, pilot balloons only were used at first, and with these a more thorough knowledge of the upper currents was obtained Later recording instruments were elevated by means of captive balloons and kites, the latter being used above the sea as well as above the land It was found that during the period September–May the general air-current had easterly components up to the greatest heights attained (10–15 kilometers), though occasionally the west monsoon appeared at the ground, its average height having been found to be 5 4 kilometers No antitrade wind aloft was found However, on one occasion when a balloon attained a height of 18 kilometers it encountered a westerly wind, similar to the strong westerly winds which were observed at heights of 10–20 kilometers on Professor Berson's East-African expedition. This phenomenon still awaits an explanation

THE newly created professorship in meteorology at the National University at Utrecht has been awarded to Dr E van Everdingen, who assumed the chair October 17. Considering the recent history of meteorology, the inaugural address, "The Third Dimension in Meteorology," was particularly appropriate In Dr Everdingen's estimation, the setting apart of a chair of meteorology indicated a recognition that meteorology was now worthy of a place among the established sciences

As a result of many requests from teachers, students and others interested in the subject, the Weather Bureau has published a second compilation of standard books dealing with meteorology and its several branches The list includes about 150 titles, the selections having been made by Mr C Fitzhugh Talman, librarian of the bureau As stated in the introduction, "the present compilation is the fruit of several years' experience in dealing with the literature of the subject, and will probably meet the requirements of the majority of American readers and students"

THE action of the management of the recent International Aviation Meet at Belmont Park in taking out insurance against loss due to inclement weather is one of the first instances of its kind in America The practise is a common one in Europe, however, especially so in England, where managers of most of the outdoor gatherings have long insured through Lloyd's against loss from wet weather. The premiums paid for the risks were relatively large at first, but of late there has been a tendency toward placing the practise upon a scientific basis, statistics having been gathered with that end in view, and in consequence the rates have been readjusted

ANDREW H PALMER

BLUE HILL OBSERVATORY,
January 14, 1911

SPECIAL ARTICLES

INTERPRETATIONS OF RESULTS NOTED IN EXPERIMENTS UPON CEREAL CROPPING METHODS AFTER SOIL STERILIZATION [1]

IT is not my intention at this time to give the details of extended experiments upon soil sterilization and its effects, nor to enter any special criticisms upon the work of other investigators I wish only to call attention to some facts, observations and conditions of the work centered about cereal cropping and experiments upon soils which may indicate that a new light may be thrown upon the conclusions to be drawn, with that light emanating from a different source than has usually been indicated by most experimenters.

Observations and Reflections.—The following features of cropping and experiments will be familiarly known to most of you.

1. New Lands, when first sown to wheat or other cereals, produce quite lavishly in seed of high quality and at slight effort on the part of the farmer. These new land yields, in this country, are quite commonly taken as the standard of what ought to be expected

[1] Read before the Society of Agronomy, Washington, D. C, November meeting, 1910

2 It is a common experience that as soon as a particular cereal crop has become general, and that usually follows in a very few years, a marked deterioration, both in yield and quality, sets in The crop, except in special years, and under rare exceptions of special farming, seldom again reaches the same high grade of yield and quality Indeed, the yield generally falls to the average for the country, above which it can be raised again only through exceptional methods, and, to the chagrin of many of our most able agricultural educators, no philosophy of cropping or land improvement seems to give the farmer the desired results with any regularity, year by year, for any long period of time The crop or variety once a favorite in a locality usually has a short life and finally gives place to a real change in agriculture, seldom, if ever, to regain its place.

3 Not many theories have been advanced to account for these results. The chemist and his followers have usually directed thought in the matter, and agriculturists, generally, have taken the chemist's dictum that marked changes have occurred in the balance of plant food relations of the soil, thus accounting for the rapid first deterioration of the crop through chemical losses noticed in the soil. Thus if a lack of proteid is found in the grain of wheat and a loss of nitrogen is observed in the soil, it has been reasoned, without foundation, I think, that the noticed chemical loss in the soil is necessarily the cause of the deficiency in the kernel When our chemical friends have, by their own analysis, discovered that there is, however, sufficient strength of soil solution regarding all known necessary chemical elements to support a crop on a particular field, the failure to reach crop quality has been quite uniformly attributed, by them and the rest of us, to slovenly methods of farming, poor physical texture of the soil, degenerated seed, etc.

Any other special theories which have been advanced in particular to account for the facts have all been strongly influenced by the recognised fact that soil can be impoverished, reduced in its chemical strength. The Whitney toxine theory would appear to be only a reflection of this troubled state of the chemical and physical mind, associated with a desire to show that a complex plant growing in the soil and air acts upon the soil after the manner of a bacterial culture in a test tube. That I may not be misunderstood, I may say that I believe that certain soils may be exhausted chemically by cropping methods, that I think it is wholly possible that the excrementia of plants under rather constant cropping may have an analogous effect upon the crop to that noted in bacterial cultures upon the substratum, but that after several years of careful trials upon wheat and flax, both under culture house conditions, and under carefully planned plot trials, I have been unable to find any point which would tend to substantiate the toxine theory Nevertheless, the contention of Mr. Whitney, that the soils of cereal regions are not particularly exhausted is, in my belief, much nearer to the truth than the contention of the chemists and others that the deteriorated yields and qualities of wheat and other cereals are due to chemical exhaustion, and especially to nitrogenous exhaustion; for neither the chemists' exhaustion theory nor the toxine theory can account, to my satisfaction, for the failure of virgin soils to produce the yields characteristic of that region when such cereal cropping was first introduced. It is a fact that such lands are quite as liable to give the crop characteristic of the old, so-called, worn-out lands, as do the older lands It is not the uniform failure of the particular crop which causes it to be dropped by a farming community, for it is evident that all of the lands of a community can not be so depleted. It is the general uncertainty of giving results, year by year, which results in abandoning or ceasing to expect a proper yield. It is evident from the foregoing considerations that there are constant interfering agencies at work in cereal cropping regions which have not as yet been properly taken into consideration, for, even under the best weather conditions possible, essentially the same weather conditions which in a new

land region give fine yields, often the crop fails to give both quantity and quality even under our best planned systems of rotation and of soil fertilization.

4 Experiments in soil sterilization applied to such old and supposedly deteriorated soils have uniformly given quite marked improvement in results. The results have been so uniformly good, whether done by steam or by chemical methods, that one or other practise has become general with the glass house gardeners and seedling plant producers They seem, long ago, to have realized what sterilization of soil has done for them, but experimenters upon field crops still look for explanation for such improvements.

5 Two very interesting explanations of such effects of sterilization, both based upon carefully planned and executed experiments, have lately been attempted; and, as my experiments cover essentially the same fields of effort, and, when published, will show almost exactly the same results but quite different conclusions, I may be pardoned, at this time, for outlining these three sets of experiments and the results, with some slight comment upon the conclusions:

Mr. A. D. Hall, of Rothamsted, England, in SCIENCE, September 16, 1910, reports upon experiments conducted at the Rothamsted farm.

Speaking of wheat, he says.

Approximately the crop becomes double if the soil has been first heated to a temperature of 70° to 100°, for two hours, while treatment for forty eight hours with the vapor of toluene, chloroform, etc, followed by a complete volatilization of the antiseptic, brings about an increase of thirty per cent., or so. Moreover, when the material so grown is analyzed, the plants are found to have taken very much larger quantities of nitrogen and other plant foods from the treated soil; hence, the increase of growth must be due to larger nutriment and not to mere stimulus.

The explanation, however, remained in doubt until it has been recently called up by Drs. Russell and Hutchinson, working in the Rothamsted Laboratory. In the first place, they found the soil, which had been put through the treatment, was chemically characterized by an exceptional accumulation of ammonia to an extent that would account for the increased fertility. At the same time it was found that the treatment did not effect complete sterilization

The question now remaining was, what had given this tremendous stimulus to the multiplication of the ammonia making bacteria? By various steps, which need not here be enumerated, the two investigators reached the conclusion that the cause was not to be sought in any stimulus supplied by the heating process, but that the normal soil contained some negative factor which limited the multiplication of the bacteria therein.

Examinations along these lines then showed that all soils contain unsuspected groups of large organisms, of the protozoa class, which feed upon living bacteria These are killed off by heating, or treatment by antiseptics, and on their removal, the bacteria, which partially escape the treatment, are now relieved from attack. . .

Curiously enough, one of the most striking of the larger organisms is amœba.

The authors, Messrs. Russell and Hutchinson, thus attempt to account for the greater wheat crop production of soil sterilization both through chemicals and through steaming, by a reverse application of the Metchnikoff theory. It would be unwise of me, not knowing all of their data or having access to the soil or the seed which they used, to enter a criticism, but from my own observations and work, I can not agree to any of the conclusions which are drawn in these paragraphs. So far as Mr. Hall has made plain in SCIENCE, they can only be matters of inference, and many conditions could enter, which would vitiate the necessity of assuming the detrimental rôle for the amœba. For example, the authors do not explain why their sterilization did not sterilize, and what happened when they did really sterilise the soil. In order to clarify the theory as proposed by Dr Hall, it would seem necessary to try real sterilization, both upon the amœba and the supposedly beneficial bacteria.

It is quite possible that the production of ammonia in soils by bacteria is a beneficial process, but I can not say wherein this theory would rest, if one should assume the presence of plenty of ammonia and plenty of ordinary nitrates in the soil. In such case, if the soil still failed to produce wheat, and proper ster-

ilization succeeded in making it produce wheat, their theory would seem to be without ground. My experiments in sterilization result in either good or bad wheat according to what I do to the seed planted therein, though there can not be any question but what in some soils increased amounts of ammonia through sterilization do have something to do with the results.

Experiment by Professor T. L. Lyon, of Cornell University, Bulletin 275, "Upon the Effect of Steam Sterilization on the Water-soluble Matter in Soils," attempts an explanation of the peculiarities of growth of the wheat plants upon soils after steam sterilization through differences in the soluble content of the soil resulting in differences in density of the soil solutions, etc. He also, however, seems to have great difficulty in accounting for some of the peculiar actions of the growing wheat plant upon such treated soils and solutions, especially in explaining what appears to be a really injurious effect upon the first growth from the seedlings, though finally followed by actual increase in crop.

In our experiments, we are able to explain most of these peculiarities of growth, noticed both in our cultures and those of Professor Lyon's admirably conducted trials, upon a biological relation of the wheat plant to certain actual disease-producing organisms and their growth relations to the crop plant, and to the various interreacting soil relations, which react both upon the crop plant and upon the disease producers.

In our experiments we find that both soil and seed may be, and usually are, infected by several very destructive wheat-destroying, parasitic fungi. Indeed, these are found to be apparently cosmopolitan in distribution with the wheat plant. They are especially transmitted in the seed internally, and, it seems quite certain, are sufficient in their influences to account for most of the causes of rapid first-crop deterioration, and for the difficulty which farmers have in introducing any sort of culture, which will again raise the standard of crop. Their exclusion, in so far as it is perfectly or imperfectly done, is sufficient to account for the anomalies indicated in soil sterilization experiments. However, in our experiments our results and conclusions have always been vitiated whenever these fungi were not eliminated.

I do not question that soil sterilization does change the bacterial content or that it does influence the soluble content of soils, but I am inclined to think that disease-infected seed and disease-infected soil will eventually be found to have much more to do with the irregularly corresponding conclusions, which have been drawn by various experimenters upon crop rotations, upon soil-fertilization experiments and upon soil-disinfection experiments than they have ever suspected. Indeed, I have but slight doubt that the whole theory of auto-intoxication (toxine theory) as applied to cropping plants, is virtually vitiated in its conclusions, because of a lack in eliminating the influences of pathogenic organisms in the experiments.

H. L. BOLLEY

AGRICULTURAL COLLEGE,
NORTH DAKOTA,
November 1, 1910

TERTIARY DEPOSITS OF NORTHEASTERN MEXICO

DURING the past two years, the geologic work under my direction in southwest Texas and northeast Mexico has resulted in the accumulation of a mass of information which materially adds to our knowledge of the Gulf Tertiaries. The fieldwork was carried on by Messrs. W. F. Cummins and W. Kennedy, assisted by Mr. J. M. Sands.

The first year's work by Professor Cummins was a general examination of the northeastern Mexico for artesian water. Following this, I had a careful section made of the Cretaceous and Tertiary deposits along the Rio Grande, and then traced the contact between the two systems southward into Mexico as far as this could be done within the scope permitted by our economic work. The widespread occurrence of the different phases of the Reynosa formation prevented direct connections of the exposures of the underlying deposits in some places, but we were able to

carry the Cretaceous-Tertiary parting with a fair degree of accuracy from the actual contact at the Arroyo del Caballero on the Rio Grande to a similar contact at Ramones, forty miles east of Monterey, and from Panalito on the Conchos River to the southern boundary of the state of Tamaulipas We hope to fill the gap between Ramones and Panalito before we finish

Numerous sections were made of the overlying Eocene to the eastward of this line of contact and good collections of fossils were made from various horizons in it, which prove that the substages recognized in Texas continue south as far as we found any deposits of this age We were able to map approximately the areal distribution of each of these.

The highly fossiliferous deposits on the Rio Grande which constitute the upper member of the Cretaceous of that region and which are known as the Escondido beds, only continue southward in this character for forty miles to a point southwest of Laguna de la Leche, where they are covered by much later deposits Where these later deposits end near the Salado river west of Rodriguez we find underlying them, in place of these fossiliferous beds, beds of blue shale without fossils, which have the same relation to the overlying Tertiary that the Escondido has through its whole extent These blue shales, which we call the Papagallos shales, are therefore considered to be the extension or equivalent of the Escondido and are found to extend south to the limit of our investigations To the south, these blue shales draw nearer and nearer to the coast until at their crossing of the Zarziza in southern Tamaulipas there is barely ten miles of Tertiary deposits between the outcrop of the shales and the waters of the gulf

On the Rio Grande and at several other points between that stream and the Pesqueria we found deposits of Midway age, as proved by its characteristic fossils, resting directly on the Cretaceous, but for the most part this basal contact is covered or obscured by the overlapping Carrizo sand The last of the Midway was seen at Ramones

When we again pick up the contact at Panalito on the Conchos River, we find both the Carrizo sands and Marine beds in contact with the blue shales of the Cretaceous, while a few miles down the river the Yegua overlaps both of these and is the substage in contact almost to the Soto la Marina. A few miles north of this river, the Yegua, Fayette and Frio are in turn covered by the San Fernando beds and beyond that point we found no further exposures of the Eocene

South of the Soto la Marina River the beds of the Eocene seem to be entirely wanting, if they were ever laid down Our drilling records as yet show no evidence of them, unless some part of the blue shale on which the San Fernandan rests be proved later to be of Eocene age No fossils have yet been found in this shale, but its general character and relations to overlying Tertiary as well as to the Escondido and to other known Cretaceous deposits seem to warrant its reference to the latter period

The San Fernando beds, which are regarded as Oligocene, were first observed at San Fernando on the Conchos or Presas River and have an extensive development to the south, entirely overlapping or replacing the Eocene deposits and resting directly upon the Cretaceous This formation, with its beds of nummulitic limestone and great numbers of cristellaria, carries an extensive and varied fauna and has a much greater development than previously observed It is succeeded by other beds of similar composition, but of distinctly later age, which in turn overlap it and reach the underlying Cretaceous shales

These later beds continue down the coast as far as Tecolutla They are well exposed at Tuxpam, where they have a highly characteristic fauna, including two very heavy oysters which are nearly round Both are of the same general shape, but one of them has on one valve four or five deep plications The echinoderms of these beds are especially noteworthy, there being probably eight species in our collection. The most abundant form is a *Clypeaster* which attains a diameter of

seven inches and which occurs in great numbers in the yellow sands around Tuxpam.

There are also casts of a large variety of other forms of bivalves and gasteropods, and as a whole the fauna is later than that of the San Fernando beds and is probably Miocene. We have called these the Tuxpam beds.

The evidence now before us indicates that the upper Tertiary deposits mark a gradually sinking coast line along the gulf border in Texas and Mexico which was arrested in the Tampico-Tuxpam region before it was further north. Thus while early Miocene deposits are on the surface almost at the present water's edge at Tampico and have only a small depth of later deposits overlying them, deposits of the upper Miocene are buried 2,300 feet on Galveston Island and are found in drilling at Saratoga seventy miles inland at a depth of over 1,000 feet.

E. T. Dumble

SOCIETIES AND ACADEMIES

THE AMERICAN PHILOSOPHICAL SOCIETY

In an address on modern physics before the American Philosophical Society, recently, Professor Ernest Fox Nichols, president of Dartmouth College, said in part:

"I shall try to review very briefly the principal ideas upon which modern physics rests and shall say something about where we think we have arrived in our search for knowledge. I need scarcely remind you that in the natural sciences as in more practical affairs, *how* we have arrived is as important as *where* we have arrived. I shall therefore spend some time in presenting detached fragments of the experimental evidence and inferences upon which certain conclusions are based, hoping in this way to illustrate some of the constructive methods of reasoning employed in research.

"The ideas which underlie all our thinking are space, time and inertia or mass. With space and time as a background, the physicist must pursue inertia and everything related to it, along every conceivable path. In this pursuit he comes upon four ultimate though related conceptions: matter, ether, electricity and energy.

It should be remembered that an important part of our present knowledge of matter, and nearly all that we know of ether and electricity, has been gained not immediately but by inference. In so many cases we see or know directly only the first and last link of a chain of events and must search by indirect means for the mechanism lying between.

"At bottom, I suppose, the ether, electricity, force, energy, molecule, atom, electron, are but the symbols of our groping thoughts, created by an inborn necessity of the human mind which strives to make all things reasonable. In this reasoning from things seen and tangible, to things unseen and intangible, the resources of mathematical analysis are applied to the mental images of the investigator, images often suggested to him by his knowledge of the behavior of material bodies. This process leads first to a working hypothesis, which is then tested in all its conceivable consequences, and any phenomena not already known which it requires for its fulfilment, are sought in the laboratory. By this slow advance a working hypothesis which has satisfied all the demands put upon it gradually becomes a theory which steadily gains in authority as more and more new lines of evidence converge upon it and confirm it.

"As we take up what we believe to be the relations of electricity to matter, we come in places upon slippery ground and the bases of our faith rest on recent foundations.

"At the outset we encounter one striking difference between electricity and matter. Every free charge of electricity exerts a force upon every other charge in the universe, just as every particle of matter exerts a force on every other particle of matter, however distant. But with matter the particles are invariably urged toward each other while electric charges may be either drawn together or forced apart depending on the kinds of charges. We have both positive and negative electricity but only one kind of matter. The bald statements of the laws of gravitation and electric force bear a strong resemblance to each other. The laws tell us how the forces *vary*, but reveal no hint of the machinery by which they *act*. Of the intimate association of electricity with matter we have learned much from careful study of the processes of electric conduction in solutions and gases."

The contributions to our knowledge gained from the recent discoveries of cathode rays, X-rays, spectroscopic studies and the amazing properties of radio-active substances were next discussed and in closing Dr. Nichols said:

"The electron has but a thousandth part of the inertia of the lightest known material atom, and this inertia it doubtless borrows from the kindly

ether and does not hold in its own right. Its behavior is that of an atom of negative electricity pure and simple Its form is spherical and not spheroidal Its size is probably less than one ten-million-millionth of an inch When revolving briskly enough in an orbit within the atom it gives us colored light of highest purity When violently jostling irregularly about it gives us white light, without it all light would be impossible

"We believe we have found electricity free from matter but never yet matter free from electricity Finally comes the suggestion that matter no less than life may be undergoing a slow but endless evolution Some of these things and many others have led physicists to suspect that if all electricity were removed from matter nothing would be left, that the material atom is an electrical structure and nothing more

"There are, however, many stubborn questions to which answers must somehow be found before the so called electron theory of matter can be accepted unreservedly As it stands it is at once a most brilliant and promising hypothesis but has not yet reached the full stature of a theory

Should it hold good the material atom with its revolving electrons becomes the epitome of the universe The architecture of the solar system and of the atom, the very great and the very small, reveals the same marvelous plan, the same exquisite workmanship The conservation of energy becomes an ethereal law and the ether the abiding place of the universal store of energy

"To end as we began, we have matter and electricity which some day we may know to be one, and ether and energy Of these we hope some time to build, in theory, a reasonable world to match the one we now so little understand

"When all the interrelations among matter, ether, electricity are separated out and quantitatively expressed, we believe our work will be complete.

"Such then is the confession of faith, the very far distant hope of the modern physicist"

November 1, 1910

THE PHILOSOPHICAL SOCIETY OF WASHINGTON

THE 687th meeting of the society was held on January 14, 1911, President Day in the chair Two papers were read:

Discrepancies among Recent Wave-length Determinations I. G PRIEST, of the Bureau of Standards.

The speaker, in introducing the subject, reviewed briefly the history of spectroscopic standards, stated that the accuracy at present desired is about 0 001Å, and gave a brief description of the "method of diameters"

In regard to the discrepancies among the results of Fabry and Buisson, Pfund and Eversheim,[1] the following conclusions were presented and supported by tabular data[2]

1 The difference $(F \& B)_{08} - P_{08}$ is not markedly systematic when the whole range of the spectrum covered is considered Considering the precision of the measures, the systematic difference that does appear is perhaps negligible

2 Throughout the range of the spectrum from 5,167Å to 6,495Å, inclusive, the difference $(F \& B)_{08} - P_{08}$ is sensibly systematic, the algebraic mean discrepancy being $+0\,0015$Å Out of the total of twelve differences to be considered in this range, only one is negative, viz, $-0\,001$Å for $\lambda = 5{,}167$Å, the limit of the range

3 Throughout the range of the spectrum from 4,282Å to 5,002Å, the difference $(F \& B)_{08} - P_{08}$ is not *markedly* systematic, although there is a slight predominance of negative values, the algebraic mean discrepancy being $-0\,00043$Å Out of the total of eleven differences to be considered, four are positive, five are negative and two are zero

4 Considering the whole range of the spectrum covered in common by the several investigators, the results of Eversheim appear to be systematically higher than those of Pfund and Fabry and Buisson by about 0 001Å.

5 *The differences, $(F \& B)_{08} - E_{08}$ and $P_{08} - E_{08}$ when grouped according to sign are also grouped in certain spectral regions as indicated in Table I In the differences $P_{08} - E_{08}$ the coincidence of the grouping according to sign and the grouping in spectral regions is pronounced and unmistakable. The spectral grouping of the positive and negative differences $(F \& B.)_{08} - E_{08}$ while less pronounced than for the differences $P_{08} - E_{08}$ is not consistent with this grouping, and the tendency of the groups in the system $(F \& B)_{08} - E_{08}$ to coincide in spectral position with groups of the same sign in the system $P_{08} - E_{08}$ is decided*

[1] *Astrophys. Jour*, 28, 195; J. H. Univ. Cir, Feb, 1910, pp 33 and 34, *Ann der Phy*, 30, pp 837–838.

[2] Initials and subscripts refer to authors and year of publication See also *Phys. Rev*, 31, 602.

Table I[5]

Group	Limits of Group	Number of Lines in Group	Distribution of Differences According to Sign: +	0	−	Algebraic Average of Differences
	(F & B)$_{av}$ − E$_{av}$					
I	4,282 4,598	9	4	3	2	0 0000
II	4,603 5,083	16	1	1	14	−0 0022
III	5,110 5,456	10	5	3	2	+0 0010
IV	5,498 6,495	17	3	5	9	−0 0014
	P$_{av}$ − E$_{av}$					
I	4,282 4,494	5	5	0	0	+0 0016
II	4,860 5,002	5	0	0	5	−0 0020
III	5,167 5,456	4	3	0	1	+0 0022
IV	5,498 6,495	8	0	0	8	−0 0038

The large discrepancies existing between Eversheim's determinations in the helium, cadmium and mercury spectra[4] and the earlier results of Rayleigh, Michelson, and Fabry and Perot were mentioned

As conditions of apparent significance in connection with conclusions 2 and 3 above, the two following facts were emphasized

1 The line of division between the group of wave lengths considered in (2) and that considered in (3) is sensibly coincident with the green cadmium reference wave length

2 Fabry and Buisson's and Pfund's correction curves for "dispersion of phase" cross each other at about this same wave-length

As a tentative hypothesis to account for conclusion 4 above, the speaker suggested an insufficient approximation in computing In support of this hypothesis, he stated that he had recomputed from the published data, the results under II., p 836, Vol 30, *Ann der Physik* (1909), and obtained values systematically lower than the ones there published These recomputed results were obtained on a ten place computing machine and so involved no approximation in computation Computation by seven place logarithms gave results *systematically* high, while computation by eight place logs checked the machine results It happens that the errors of the seven place table are additive instead of compensating in this case, so that the error in the final result may amount to + 0 002Å There is a possibility of the approximate logarithmic computation introducing a *systematic* error owing to the fact that all wave-lengths are referred ultimately either to the green or red cadmium wave lengths as standards, and to the fact that the values of K (see p 835, Vol 30, *Ann der Phys*) nearly enough equal to fall at the same point in the log table may be expected to frequently occur As to the importance of this latter condition, nothing can be said without consulting the original data It seems possible, however, that this condition if it occurs often enough, in connection with the error due to approximation in log λ, may cause a discrepancy about large enough to account for the observed discrepancy between the results of Eversheim and the other investigators

[5] Data from same sources as mentioned in footnote 1

[4] *Zs für wiss. photog*, 8, 148, March, 1910

Ocean Currents and Barometric Highs and Lows
Dr W J Humphreys, of the United States Weather Bureau

In the first part of the paper the speaker dealt with the five barometric highs on the oceans which remain substantially fixed in position throughout the year though varying in intensity, three of which are in the southern, and two in the northern hemisphere In the second part of the paper the speaker discussed the Aleutian and the Icelandic regions of low barometric pressure

A brief review was given of the explanations advanced by past investigators to account for the existence and character of these regions of high and low barometric pressure, none of which appeared adequate to account for all of the observed facts

Lantern slides were exhibited showing the isobars, isotherms and ocean currents over the ocean areas, and the relation of these to the existing high and low-pressure areas was discussed at some length, the purpose of the paper being to show the physical reasons for the existence of these highs and lows and to explain why they are where they are actually observed to be (This paper will appear in full in an early number of the Bulletin of the U S Weather Bureau.)

R. L Faris,
Secretary

SCIENCE

FRIDAY, FEBRUARY 17, 1911

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THE APPOINTMENT AND TENURE OF UNIVERSITY PROFESSORS[1]

THE subject, appointment and tenure of university professors, divides itself naturally into two parts. With the question of appointment will be considered also that of promotion. The statements of fact given below are confined to the twenty-two universities which belong to this association, viz.: California, Catholic, Chicago, Clark, Columbia, Cornell, Harvard, Hopkins, Illinois, Indiana, Iowa, Kansas, Michigan, Minnesota, Missouri, Nebraska, Pennsylvania, Princeton, Stanford, Virginia, Wisconsin and Yale.

FACTS AS TO APPOINTMENTS AND PROMOTIONS

The appointment and promotion of members to professorial rank, with the exception of associate professors at Catholic University, rest with the governing board. Instructors and men of lower ranks are at some institutions appointed by the senate, faculty or president. Thus at Columbia they are appointed by the faculty subject to confirmation by the board, and such confirmation is purely formal. The governing boards have different names in different institutions. In the endowed institutions the boards are usually called trustees, in the state universities, regents, but neither of these rules is invariable. At Harvard and Yale the governing boards are called corporations, at Missouri the governing board is one of curators, at Iowa a board

[1] Address delivered at the meeting of the Association of American Universities at the University of Virginia, Charlottesville, November 10–11, 1910.

of education, at Virginia the rector and visitors.

The important point with reference to appointments and promotions is not as to the nature of the organization which makes the appointment, but as to the representatives that make the recommendations to the board, for in most cases as long as these representatives have the confidence of their board, an appointment or promotion when recommended is made The functions of the board in this matter are primarily financial The creation of a chair rests to a large extent with the board, since whether or not it can be supported depends upon financial considerations If the recommendations made can be financed, they are likely to be accepted; but if not they may be rejected on this ground Also on other grounds a board may exercise its veto power But almost without exception the boards do not regard it as their function to take the initiative in appointments and promotions Such initiative they place with the educational officers

Occasionally the members of a board of trustees have dealt directly in the appointment of members of the instructional force This is true at the present time to some extent in one of the institutions of the twenty-two, but this situation is exceptional and even in this institution probably temporary Almost without exception, when an appointment has been authorized by the board, the recommendation of the president or some other representative or representatives of the faculty is decisive.

In seventeen of the twenty-two institutions of this association the recommendations as to appointments, promotions, and removals rest with the president, chancellor or provost of the institution. In this paper the term president will be used to comprise all three. Of these seventeen institutions, in three the recommendations can be made only after the concurrence of or consultation with other academic officers These are as follows

At Kansas the recommendations go to the governing board through the chancellor, but such recommendations must come jointly from him, the dean, and head of the department concerned, the chancellor having the veto power if he wishes.

At Cornell the "statutes require that the president shall consult with the heads of departments before making nominations in these departments"

At Stanford appointments and promotions, with reference to which the president has the initiative, must be submitted to an advisory board consisting of nine members of the rank of professor, and when the president submits his recommendations he must state whether or not they have the approval of the advisory board

A part of the advisory board is elected from specified groups of departments and others are elected at large, all elections being without nominations by secret ballot of the academic council The term of office is three years, and one third go out of office each year Every nomination, promotion or removal of the instructional force, large or small, goes before this board In connection with this matter it is to be said that Stanford has no deans, the president dealing with reference to each department through its executive head, who is annually appointed by the president with the approval of the advisory board.

The five institutions in which the recommendations to the board are not made by the president are as follows:

At the Catholic University of America appointments of professors are made by the board of trustees "after consultation with the academic senate and with the faculty of the school comprising the depart-

ment to which the appointment is to be made." Associate professors "may be appointed by the academic senate, after consultation with the faculty of the school to which the appointment is to be made." The academic senate consists of the rector as president, the vice rector, the general secretary, the presidents of the university colleges, the deans of the faculties and two professors from each faculty.

At Johns Hopkins appointments are made by the board upon the recommendation of the academic council. This council consists of the president and ten professors.

At Minnesota appointments are made upon the recommendation of the dean of the college concerned after consultation with the president. In this case the usual positions of the dean and president are reversed.

At Pennsylvania the faculties of the several schools make recommendations for appointment and promotion to the trustees and provost. In case the provost does not concur in a recommendation, he retains the right of veto, but as a matter of fact has in no case exercised it.

At Yale "nominations for positions in the faculty of any existing department except the graduate school shall come originally from the permanent officers or governing board of that department." The term department, as here used, is equivalent to school or college. The faculty of the school or college acts upon the recommendation of a committee of five professors appointed by the dean, two at least of which are from departments of study outside of the vacant professorship. This committee after conference with the president and dean presents its recommendations to the faculty of the school or college. The recommendation of the school or college is transmitted to the corporation. In the graduate school the nominating committee is appointed by the president rather than the dean.

Also at Harvard in the medical school the recommendations are made to the governing board by the full professors instead of by the president.

The procedure at Columbia is somewhat exceptional in the matter of appointments, in that recommendations to the trustees for men of professorial rank are by their own board of education. Since, however, the president presents the names and records of the persons proposed with his expression of opinion concerning them, the result is the same as if he made formal recommendation to the board, and therefore Columbia is included in this class of institutions.

In the case of the academic senate of the Catholic University, the academic council of Hopkins, the faculty of Yale, the president is a member, and at Yale he must be consulted by the faculty nominating committee, not only so, but "no decision of the faculty shall be valid which does not receive the concurrence of the president unless it shall be discussed and approved by the corporation."

Therefore it is clear that even in these five cases the president has much influence in the matter of appointments, etc. Since the president makes the recommendations to the governing board as to appointments, promotions and removals in the case of seventeen institutions and his recommendations are usually accepted, the point of paramount importance in connection with appointments and promotions is as to the manner in which the president exercises his authority. As we have already seen, in three institutions, the president is required to advise with a definite body of officers before acting. In one case the president has a definitely announced plan of taking

advice before making a nomination. Thus, in California, the president has "at his own option and by his own suggestion, called together a committee consisting of professors of five nearest related departments for conference as to the nomination of any one professor The nomination of assistant professors and instructors is made by the president after conference with the departments concerned"

In the great majority of cases, fourteen in number, so far as I have been able to ascertain, the president makes his recommendations without any definitely announced plan of conference but with a very definite method of securing advice

1 Usually where the university is organized into schools and colleges with deans or directors, the nominations of all officers in a school or college are made after close consultation with and the concurrence of the dean or director Indeed, in many institutions the dean or director is expected to take the initiative in going over the ground and getting the material ready to present to the president This is especially likely to be true of the professional schools, but in some institutions is true of all schools and colleges

2 The president frequently, and in the case of some institutions usually, consults directly with the professor serving as the executive head of the department, and he may also consult with other professors of the department This is especially likely to be true of the college of liberal arts or a college of arts and sciences, as, for instance, at Harvard and Michigan In this case the duties of the deans mainly concern the students This situation is historical, in former years the president of the modern university having had as his main or sole function the presidency of the college of liberal arts

In consequence of this situation, in many institutions, the relation of the president to the departments of the college or colleges of arts and sciences is more intimate than with reference to the departments of other colleges

3 The president may consult with both the deans and the professors of the department concerned, and not infrequently he may consult with the professors of allied departments

I think it may be said that in general the president in the exercise of his authority of nomination takes advantage of all available sources of information Any president who acted independently would probably have a brief tenure of office In short, it is the general rule for the president before making a recommendation to have the concurrence of the professors of the department concerned, the dean or director of the school or college interested, and frequently the professors of allied departments

Nevertheless, it does not follow that the president always follows the recommendations received While he would not nominate a man contrary to the wishes of interested officers, he may decline to make a nomination or promotion of a man recommended by a department In other words, he exercises the veto power In some cases the president instead of exercising the veto power transmits the recommendations of the department with the information that he does not concur in them The result is the same The presidents of this association report that under such circumstances the governing boards hold the president responsible and invariably refuse to make an appointment which has not his concurrence While the president must necessarily depend upon the sources of information mentioned with reference to professional attainment, another important factor in the success of a professor

and his fitness for work in an institution is the personality of the man in reference to energy, adaptability and other general qualities Concerning these points the president has a right to a judgment If a man does not in his opinion come up to the standards which he holds he may decline to make a nomination or recommendation for promotion urged by a department

Finally, after a department is once established, very exceptionally the president might take the initiative in the nomination of a man of professorial rank Such an action could only be justifiable in case the president does not have confidence in the department as it exists This situation is more likely to occur in institutions that are trying to raise their faculties to a higher standard, for instance from that of a college to a university basis, than in those institutions the departments of which are well established and on a somewhat permanent basis.

The extent to which the president personally participates in the councils leading to the nomination of a man depends largely upon the proposed rank of the man His participation is usually more intimate with reference to the nomination of men whose appointments are indeterminate—professors and associate professors, he is perhaps more likely to accept the judgment of others without close personal investigation in the case of the assistant professor who is appointed for a definite term, and a mistake in reference to which is not so serious a matter He usually accepts without question the recommendation of the department or a dean for instructors and lower ranks.

THE POWER OF THE PRESIDENT.

It is clear from the above statement of facts that the president of the university for the great majority of the institutions of this association occupies a very important place in the building up of the staff. The question therefore arises as to whether his authority should be curtailed. During the past half dozen years a number of papers[2] have appeared which have strongly urged this, not only with reference to appointment and removal, but in other directions The writers of some of these have gone so far as to state that the office of president should be abolished

With reference to the particular point under discussion—the appointment and promotion of the instructional staff—the only substitute for the exercise of the nominating power by the president which has come to my notice is that the faculty shall elect and dismiss the professors, this being subject merely to the veto of the trustees This proposal goes farther than is the practise of the Prussian universities There, the faculty nominates three members for a vacant professorship, from among whom the minister of education selects one, but in one case out of three during the last seventy years, according to President Pritchett,[3] the minister has gone altogether outside of this list The reason assigned for so doing was that the faculties are likely to be influenced by "personal considerations in their choice, not by considerations of the highest usefulness of the man to be chosen" The implication that if in America the office of president were abolished and his duties assigned to the faculty, the situation would be similar to

[2] This class of papers is illustrated by "Closer Relations between Faculties and Trustees," James P Munro, *Science*, Vol 22, 1905, pp. 848–855; "Externalism in American Universities," George M Stratton, *Atlantic Monthly*, Vol. 100, 1907, pp 512–519, "Academic Control," J. McKeen Cattell, SCIENCE, March 25, 1906; "Academic Aspects of Administration," Joseph Jastrow, *Popular Science Monthly*, Vol. LXXIII., October, 1908, pp 326–339

[3] Henry S Pritchett, *Atlantic Monthly*, Vol 96, p 296

that of Germany, is erroneous, since in Germany the minister of education to a large extent performs the functions that the president does in America Indeed, with reference to the appointment of professors it is clear that the power of the minister in Germany is quite as great as that of the president in America

The proposal to have the faculties make nominations of professors has a certain plausibility, and, as we have seen, is practised in four institutions, but the plan has not generally appealed to the governing boards, nor do I think it probable that it will in the future.

The fatal defect in the administration of a university by the faculty rather than by the educational executive officers is its extravagance. When an educational institution was small the faculty could do its administrative work But in large universities, in the consideration of educational policies, which are agreed should belong to the faculty, progress can only be made by sending a matter first to a faculty committee The committee spends much time in whipping the matter into shape It then goes to the appropriate faculty After consideration more or less prolonged, if favorably acted upon, it goes to a university faculty, academic senate, or academic council This body in turn goes over the subject and finally acts It must be admitted that this procedure is extremely expensive

While expensive, I am not arguing for a change University unity is more important than administrative efficiency; and in order to secure harmony in a university it is necessary that the faculty exercise authority with reference to educational policies While costly, it will be necessary to leave educational policies in the hands of the faculty

If all the questions of administration, including that of appointment, were to be handled by the faculty acting either as a committee of the whole or through its committees which in turn report to the faculty, the faculty would have much less time to devote to their main duties—instruction and investigation. This would be the result of "increasing the legislative and administrative responsibility of the faculty" as proposed by Munro.[4]

At this point there is a curious inconsistency in the position of many members of the faculty At the very same time that they are complaining of the extent of authority of the executive officers they are also complaining of the amount of committee work which is required of them. They state that even with the situation as it is so much committee work is required that they are unable to do satisfactorily their own work

These and other considerations have resulted in a tendency not in the direction of curtailing the power of the president in reference to appointment, but, on the contrary, for the governing boards to place that power in his hands and hold him responsible This is illustrated by Virginia, an institution which, after having lived nearly one hundred years without a president, has created that office; and the University of Toronto which was even more recently reorganized along American lines with a president having practically the same powers as in the United States

The only constructive suggestion which I have seen in reference to the president is to have the professors, rather than the governing boards, elect him and determine his powers.[5] While it is not probable that the

[4] "Closer Relations between Faculties and Trustees," James P. Munro, SCIENCE, Vol. 22, 1905, pp 848–855.

[5] George M Stratton, "Externalism in American Universities," *Atlantic Monthly*, Vol. 100, 1907, pp. 512–519.

governing boards will consider this proposal, if it were adopted, I suspect it would turn out that in order to secure efficiency of administration the president would exercise substantially the same powers that he now does; and this would be the case whether or not it was originally so planned. If an educational executive officer is essential, then he must have the powers which are necessary to give efficiency, and as a result of evolution these powers would probably not very greatly differ whether the officer were elected by the faculty or by the trustees. Whether the faculties would choose presidents more wisely than the trustees may well be doubted, and the exercise of the function would be very likely to introduce factional strife which might endanger the usefulness of the man selected.

In reference to the particular point under discussion—the appointment, promotion and removal of professors—it can not, I think, be charged that the president does not fully realize the seriousness of his responsibility; indeed, of all of his functions that of nomination to the faculty is the one through which he is able to make the largest impression upon the development of an institution. If he is sufficiently wise in using the information and recommendations of the deans and other officers as to be successful in this and a faculty of high grade is built up, the reputation and influence of the university will be a rising one.

It appears probable that if there is any formal development in the near future in reference to appointment, it will not be in the direction of taking away the nominating power from the president, but toward having the president exercise the power reposed in him, after consultation or concurrence with some other académic body, as in the case of the council at Hopkins and the advisory board at Stanford. In this connection the question arises as to whether or not it would be better for the more numerous institutions in which the president exercises this power without any regulation, but under well defined principles, to formulate them into rules. Upon this point there doubtless will be great difference of opinion.

If future development goes in the direction of formulating rules for the advice of the president in the exercise of his power of nomination, it seems to me that it would be advantageous for them to be along the lines of providing a changing body for each case. The great strength of this plan would be that the president would continue to consult all the interested parties; whereas, an academic council may be largely composed of men who do not know the facts at first hand. This point is illustrated by the self-imposed rule of the president of the University of California, who, when considering the appointment of a man of professorial rank, calls together a committee of the professors of the five nearest related departments for conference. But this very case illustrates the difficulty of the formulation of the principles of advice into rules. In some instances it might not be advisable to consult with so many departments as five, and in other cases more than that number.

Considering the whole situation, I think it would be well to announce as a fixed practise, where this is not already understood, that the president in the exercise of his authority of recommendation to the governing board as to appointments, promotions and removals, should do so only after consulting the executive officers of the school or college concerned, and in cases where he regarded it as advisable, the members of the department concerned, with the recognized right of consultation

upon the part of the members of such departments If this were done, the faculty, the governing board and the public would know that the president in the exercise of his powers of recommendation has had the advice of some responsible academic body, and the cry of "czardom," "tyranny," "the powers of academic life and death," in reference to the president, which in most cases is wholly without foundation, would be lessened

THE FACTS AS TO TENURE OF APPOINTMENT

In general, the appointments of professors are "during good behavior," or "at the pleasure of the board" In some institutions the appointments are of indefinite tenure, or permanent In all cases the meaning is the same, that the appointment is one for life to the age of retirement, provided the appointee is efficient

The only variations from the above are as follows At the Catholic University, professors may be appointed for an indefinite period, for a specified time, on probation, or to serve a temporary purpose At Clark professors are appointed first for a term of five years and if reappointed "at the pleasure of the board" At Columbia appointments to professorial rank are for three years, or at the pleasure of the board Other institutions make occasional appointments for a definite term

In general, the terms of appointment of associate professors are the same as for professors (Here are included the junior professors of Michigan) The exceptions are as follows· At Hopkins the associate professor for the first five years has an annual appointment, and thereafter on the professorial basis At Stanford associate professors are appointed for five years Some institutions do not have the rank of associate professor

Assistant professors are usually appointed for a definite period, often for three years, but sometimes a shorter or longer period The institutions varying from the three-year term are as follows California, one year, Catholic, period either indefinite or determinate, Chicago, four years, Columbia, one year (called junior professors), Cornell, five years, Harvard, five years; Hopkins (associates), one year, Kansas, annual for two years, thereafter permanent, Illinois, permanent, Iowa, permanent, Indiana, permanent, Minnesota, indefinite, Missouri, indefinite, Nebraska, permanent, Princeton, permanent, preceptors with the rank of assistant professor, for a specified term, Catholic and Hopkins do not have assistant professors

It is notable that with the exception of Princeton the institutions which at once or almost immediately make the appointments of assistant professors for a permanent or indefinite tenure are a group of state universities in adjacent states—Indiana, Iowa, Illinois, Missouri, Kansas, Nebraska and Minnesota For this geographic association I have no explanation to offer, but doubtless a sufficiently deep investigation would find one

While not properly included in the scope of this paper, for the purposes of comparison the tenure of instructors is also given For the most part instructors are appointed for a period of one year The exceptions are as follows: Chicago, three years, Cornell, after one or more year's experience, two years; Harvard, annually, or for a term of three years; Indiana, permanent; Minnesota, indefinite; Nebraska, permanent, Virginia, usually indefinite, but subject to termination at the instance of either party, Yale, one or two years.

From the above statement of facts it appears that the practise of the institutions belonging to the Association of American

Universities with reference to tenure of appointment is well crystallized. Appointments of professors and associate professors are practically permanent. While in several institutions assistant professors are appointed for an undetermined or permanent term, commonly they are appointed for a definite term, and there is a strong tendency to make it three years. For instance, in some institutions where the appointment in the past has been for a longer period, five years, it has been changed to three years, as recently at Yale. In other cases where the appointment has been for a briefer term than three years, it has been extended to three years.

I am not aware of any criticism as to the above principles concerning tenure of appointment. They seem satisfactory alike to the trustees and to the faculty. In making the appointment of assistant professor for a period of years greater than one it is recognized that the man is far enough along so that the question need not be raised each year as to his fitness to continue, but also in the majority of institutions it is recognized that after having had a reasonable time in which to "make good" the question should come up without embarrassment to the authorities as to whether or not he shall be reappointed. Also at this time the question of his promotion naturally arises.

PROFESSORS SHOULD BE EFFICIENT

The question now arises as to what should be done in the case of a man of professorial rank, whether full, associate or assistant, who is not efficient. Not infrequently papers with reference to this subject appear to assume that universities exist for the instructional force, that the main thing is to give that force a comfortable and happy time, an opportunity for a somewhat easy existence as a teacher, leisure for browsing through literature, and long vacations. I shall not consider the merits of this hypothesis, but shall say merely that I adhere to the ancient view that universities do not exist for the instructional force nor even for the administrative officers, which include the president, but that they do exist for the students and for the public. This view I suspect governing boards as representatives of the public will continue to insist upon.

If this view be accepted, it follows that the instructional force of a university, both young and old, must be efficient. Whether or not a man is retained in a faculty should depend upon his capacity to meet his duty to the institution. There is no possible excuse for retaining in the staff of a university an inefficient man. In rapidly growing institutions, among the older men, it often happens that there are those who have worn out their lives in their service, and who have fallen behind the standard. In justice these men can not be requested to resign or be summarily dismissed. If in any institution there are such men, they should be pensioned. But the right of efficient instruction by the students should be respected. And certainly the young men on the staff of a university can claim no exemption from the principle that they are to be judged by the efficiency of their service to the students and to the public. This means that they must be good teachers or good scholars, or both.

Strongly contrasting with the above view is that presented by Lawton,[6] who says in reference to the professor: "His position should be as secure as one on the Supreme Bench, unless senile decay, permanent mental or physical disease, or fatal moral

[6] William C. Lawton, "The Decay of Academic Courage," *Edu. Rev.*, Vol. 32, p. 402.

lapse makes clearly obligatory his enforced (if not voluntary) retirement by a court composed largely of his associates

And Stratton[7] says· "The faculty alone should normally have the power to dismiss its own members."

If the above views were accepted what chance would there be for a change in a chair occupied by an inefficient man? Can it be assumed even with any degree of plausibility that there would be one change per annum in the entire twenty-two institutions of this association?

Throughout history it has been the desire of the privileged classes to allow none but the members of the class itself to remove, reduce or punish its own members, and oftentimes these desires have been recognized But in modern times for the majority of civilized nations, such privileges have been taken from the nobility, they are not likely to be instituted for the class of professors in America

The responsibility of the governing board and the executive educational officers to the students and to the people is vastly greater than any obligation to the professor The funds for the disbursement of which they are responsible are trust funds which to the best of their ability should be expended to accomplish the purpose for which the funds are available, and this is true whether the money comes from the public treasury or from private sources. If a professor does not efficiently perform his work he should not be continued. For a given institution, if care has been exercised in the building up of the faculty the cases requiring so drastic action as request for resignation or removal will be only occasional

[7] George M. Stratton, "Externalism in American Universities," *Atlantic Monthly*, Vol. 100, 1907, pp. 512–519

In the great majority of cases when the right of change is exercised because of the inefficiency of a professor, it has made no difficulty or comment, indeed, has rather strengthened the confidence of the faculty and the public in the governing body. For my own part, it appears clear that the ultimate authority to ask the resignation of or to remove a professor must rest with the governing body under the advice of the officer or officers who make recommendations as to appointments and promotions The exercise of this authority should be clearly exceptional, but certainly it should be performed whenever a professor is clearly inefficient.

The only cases which have occasioned any serious discussion in reference to the tenure of professors have been those in which for some purpose, apparently not directly connected with the duties of a man or his good behavior, he has been dismissed For such extremely exceptional cases I would propose no rule Full responsibility must rest with the appointing authorities

If they exercise the power of removal arbitrarily, the public will hold them sternly accountable, and their institution will suffer, because good men will not be so likely to go to a university in which the power of removal has been exercised in an indefensible manner, or exercised in a manner in reference to which there is any doubt. The public will always give the professor the benefit of the doubt.

In some cases where an institution has had a fairly good defense for the removal of a man, it has suffered for years in consequence of so doing. The punishment of the offending university by public condemnation is the most effective protection for the professor against arbitrary or unjustifiable removal

CHARLES RICHARD VAN HISE

SCIENTIFIC NOTES AND NEWS

Dr. Henry Fairfield Osborn, president of the American Museum of Natural History, was made curator emeritus of the department of vertebrate paleontology at the last meeting of the executive committee.

Dr Samuel G. Dixon, professor of hygiene in the University of Pennsylvania, and Dr George Wharton Pepper, professor of law, have been elected trustees of the university.

Dr W K Rontgen, professor of physics at Munich, and Dr Ewald Hering, professor of physiology at Leipzig, have been appointed knights of the Prussian order pour le mérite Dr Gustav Retzius, formerly professor of anatomy at Stockholm, has been appointed a foreign knight of this order.

An international committee has been formed to celebrate the jubilee of Professor Gaston Darboux's connection with university education, the work he has done for mathematics, and his services as permanent secretary of the Paris Academy of Sciences. It is proposed to present Professor Darboux with a medal, reproducing his portrait, together with an address signed by the subscribers

On February 8, a portrait of Professor W Boyd Dawkins, F R S, will be publicly presented to the University of Manchester where he has been professor of geology

Professor H. Lorentz, of Leiden, has been elected a foreign member of the Paris Academy of Sciences to succeed Schiaparelli

The Chemical Society of France has elected, as we learn from *Nature*, the following foreign honorary members: A. v. Baeyer, Munich; Emil Fischer, Berlin; P Guye, Geneva; L Henry, Louvain, Belgium, O Istrati, Bucharest; A. Lieben, Vienna, Louguinine, St Petersburg, Raphael Meldola, London, Paternò, Rome, Sir Wm Ramsay, London, and Ira Remsen, Baltimore. The late Professor S. Cannizaro had also been nominated by the council, but his death prevented his nomination being confirmed by the general meeting of the society.

The Adams prize has been awarded by Cambridge University to Professor A. E. H. Love, F R S, formerly fellow of St John's College and now Sedleian professor of natural philosophy at Oxford, for his essay entitled "Some Problems of Geodynamics"

Dr. Karl Chun, professor of zoology at Leipzig, has been awarded the gold Cothenius medal of the Halle Academy of Sciences.

Dean H C. Cooley, of the University of Nebraska, Mr Bion J. Arnold, of Chicago, and Dr J A L Waddell, of Kansas City, have received the degree of doctor of engineering from the University of Nebraska

Dr Chas K Mills and Dr Wm G Spiller, of the neurological department of the University of Pennsylvania, have been elected foreign corresponding members of the Société de Neurologie of Paris

Miss Mary C Dickerson has been appointed curator of the department of woods and forestry and assistant curator in herpetology at the American Museum of Natural History

Dr. David J Davis, of the Memorial Institute for Infectious Diseases, of Chicago, has been appointed pathologist to St Luke's Hospital, Chicago

Dr Frank M Surface has resigned his position as associate biologist, at the Maine Experiment Station, in order to accept a position as biologist in the division of animal husbandry, in the Kentucky Agricultural Experiment Station at Lexington.

Mr A Imachi, of the Formosa Experiment Station, at Taihoku, spent the week of December 31 to January 9 with the Bureau of Plant Industry in Washington Mr. Imachi is on his way to Yucatan to study the sisal hemp industry

According to Reuter's Agency the British South Africa Company has decided upon the despatch of a special commission to investigate sleeping sickness in Rhodesia. The commission will consist of Dr. Aylmer May, principal medical officer of northern Rhodesia; Dr. A. Kinghorn, of the Liverpool School of Tropical Medicine; Dr. Leach, of the Northern Rhodesian Medical Service; Mr O. Sil-

verlock, entomologist, and Mr Jollyman, bacteriologist

It is stated in *Nature* that at a recent general meeting of the Liverpool Astronomical Society it was resolved to raise a special fund for the purpose of a memorial to the late Mr R C Johnson, whose long connection with the society, in which he filled the positions of secretary and president, and his services in the interests of astronomical science, suggest that some permanent recognition of his work should be made

A memorial in marble to the late Sir John Evans, the anthropologist, has been placed in the parish church of Abbot's Langley, Herts, where he lived for sixty years

According to information received from Timbuctoo the remains of Alexander Gordon Laing, the African traveler, who was murdered in 1826 while exploring the course of the Niger, have been discovered at Saebb, some 50 kilometers north of Timbuctoo. The discovery was made by M Bonnel de Mézières, who had been commissioned by the governor of the French Upper Senegal and Niger Colony to proceed to Taudeni, some 300 miles north of Timbuctoo, in order to examine the salt mines of the district

Professor L. P. Kinnicutt, director of the department of chemistry in the Worcester Polytechnic Institute, well-known for his important contributions to sanitary chemistry and sewage disposal, died on February 6, aged fifty-six years

Dr Edward Gamaliel Janeway, professor of medicine and dean of the University and Bellevue Hospital Medical College, one of the leading physicians of the country, died on February 10, aged sixty-nine years

Dr Willibald A Nagel, professor of physiology at Rostock, has died at the age of forty years

M E A Léveillé, the French entomologist, has died at the age of seventy years

Professor Eduard Hagenbach-Bischoff, formerly professor of physics at Bâle, has died at the age of seventy-eight years.

Foreign exchanges announce the deaths of three astronomers M Gustav Leveau, known for his work in celestial mechanics and for more than fifty years an officer of the Paris Observatory, M Rozé, astronomical lecturer at the École Polytechnique, Paris, and Dr F. W Hermann Leppig, astronomer in the Leipzig Observatory

The Wabash College Botanical Society will this year send a representative to the Woods Hole Biological Laboratory to occupy a table which they will support

UNIVERSITY AND EDUCATIONAL NEWS

Dr and Mrs Robert W Long, of Indianapolis, have given $200,000 in real estate to the medical department of Indiana State University

By the will of Mrs Emily H Moir, of New York City, Barnard College received $10,000 Harvard University, Princeton University, Lincoln University and Howard University receive shares of the residuary estate

Illinois College, at Jacksonville, Ill, received recently $5,000 from Mr Edward F. Goltra, of St Louis This contribution is towards a new endowment of $150,000 which the college is raising Mr Andrew Carnegie has contributed one half of the amount, friends and alumni have thus far contributed about $65,000

Plans have been proposed to unite the University of Pennsylvania with the Pennsylvania State College and to make the relations between the university and the state more intimate

The sum of £25,000 required for the purchase of the site for new chemical laboratories at University College, London, has been completed by a gift of £4,500 from Mr Ralph C. Forster The total sum required for the purchase of the site and the erection of the laboratories was £70,000.

Dr. C. H. Neilson, professor of physiological chemistry in St Louis University School of Medicine has been made professor of medicine and director of the department. The chair in medicine has been put on a salary basis Dr. Neilson is an A B. from Ohio Wes-

leyan University, received his Ph.D. in physiology at Chicago in 1902 and his M.D. from Rush Medical College in 1905. Before going to St. Louis he was instructor in physiology in the University of Chicago, and at the Marine Biological Laboratory at Woods Hole.

MRS. MARGRETE BOSE has been appointed professor of chemistry in the University of La Plata. Her husband, Dr. E. Bose, is professor of physics in the university.

MR. JAMES LEES, of the University of Bristol, has been appointed lecturer in engineering in the South African College, Cape Town.

DR. FRANZ HOFMANN, professor of physiology at Innsbruck, has been called to the German University of Prague to succeed Professor Gad.

DISCUSSION AND CORRESPONDENCE

LABORATORY TABLES

TO THE EDITOR OF SCIENCE: Several months ago I read with interest in SCIENCE Professor Augustus H. Gill's suggestions for chemical laboratory furniture and fittings. Among other things he discusses various kinds of materials and surfaces for table tops. It occurs to me that it may be of sufficient interest to warrant calling attention to still another kind of surface for laboratory tables.

In our testing laboratory at The York Manufacturing Company we have tables with tops of ordinary wood. On this there are placed sheets or slabs of heavy asbestos board, one fourth inch thick. These are fastened in place by a few small brads driven around the edge. All around the outer edge of the table there is a narrow strip of wood of the same thickness as the asbestos board, making a permanent border. This, as a matter of course, is nailed in place. It prevents the edges of the asbestos from becoming frayed out. The advantages of this asbestos surface are almost self evident. Flasks and beakers containing hot water or solutions can be stood upon it without fear of their cracking. There is also little risk of breaking glassware by setting it down a little too hard, as is often the case on slate or stone or even wood, where particles of grit may happen to be. And of course the resistance of the asbestos to fire and heat is too well known to need any comment. There is the further advantage that when the asbestos slab becomes old and worn it is easily replaced without in any way disturbing the table, thus making the latter practically new.

We have found this plan highly satisfactory and pass on the suggestion for any who may desire to try it. It is quite possible that it is an old device after all.

C. H. EHRENFELD

YORK, PA.

A FORMULA FOR OPTICAL INSTRUMENTS

IN many surveying and optical instruments a ray of light is reflected by a pair of plane mirrors. And if ϕ be the angle between said mirrors, and the entering light ray lies in the plane commonly perpendicular to them, then, of course, the doubly reflected ray must cross its original path at the angle 2ϕ. And, although the ray sway from side to side, so long as it preserves its parallel position to this commonly perpendicular plane, so long also is the crossing angle still 2ϕ.

But now, should the entering ray be deflected at a variable angle θ to this commonly perpendicular plane, then the question arises as to the resultant effect upon the crossing angle, a problem that constantly arises in practise, and yet one, I believe, that the text-books leave unanswered.

The single solution is as follows: letting ϕ be the angle between the two mirrors, and θ be the independent variable angle that the entering light ray makes with the plane commonly perpendicular to the said mirrors, while δ is the crossing angle desired. Then,

$$(\cos\theta)\ (\sin\phi) = \sin\tfrac{1}{2}\delta,$$

a very simple formula, that can be easily demonstrated by elementary trigonometry.

In the special cases where the entering ray is normally inclined to the commonly perpendicular plane, and it be asked what errors may be produced by changes in the direction of that ray? we should simply determine, first, the angle ϕ between the two mirrors, and

secondly, the angle θ that the ray was designed to have with the commonly perpendicular plane, when the above formula will prove itself, by giving us the correct bend δ in the ray that the instrument was designed to produce. Whereupon any error on deflection in the entering ray either does or does not make a new angle θ' with the commonly perpendicular plane, giving us, therefore, by the above formula the new value of δ

ALAN S. HAWKESWORTH
UNIVERSITY OF PITTSBURGH

THE INSUFFICIENCY OF DATA ON ENVIRONMENT GIVEN IN PAPERS DESCRIBING DEEP-SEA AND OTHER MARINE ORGANISMS

TO THE EDITOR OF SCIENCE: In examining a number of recently published papers on corals, foraminifera and other marine animals, especially for the purpose of ascertaining the temperature conditions under which the organisms live, I have been particularly impressed by the fact that very rarely are any definite data given on the temperature of the waters from which they were taken. As it is a generally known biological fact that temperature is one of the most influential factors in determining geographic distribution, it is highly important that precise information on this subject should be available. In fact, the data on the physical conditions under which an organism was collected should always be presented as fully as possible. Depth, temperature, nature of the bottom, and relations to marine currents, are important factors. As so many zoologists are engaged on the description of marine faunas, and as it is more or less habitual to give very meager data on the conditions under which the organisms described live, this appeal for more detailed information is made to the body of investigators through the columns of SCIENCE.

T. WAYLAND VAUGHAN

SCIENTIFIC BOOKS

The Age of Mammals in Europe, Asia and North America By HENRY FAIRFIELD OSBORN. Illustrated. New York, The Macmillan Co. 1910.

Students of paleontology have awaited impatiently the past few years a promised work on extinct mammals by Professor Osborn. In his "Age of Mammals," as it has recently appeared, expectations have been more than realized For more than a century, beginning with the classic researches of Cuvier, our knowledge of extinct vertebrates has been increasingly widened, and of no group so greatly as of the mammals. In North and South America, throughout Europe, in India, and more recently in Africa, discoveries have followed discoveries so rapidly that all but the expert have nearly given up in despair the attempt to follow and understand. And it is superfluous to say that in no part of the world has the progress of our knowledge been so rapid as in North America. Those famous pioneers in American paleontology, Leidy, Cope and Marsh, followed soon by Scott and Osborn, and later by Wortman, Hatcher, Matthew, Merriam, Sinclair, Gidley, Peterson, Douglass, Loomis, as well as others whose names may be omitted here without invidiousness, have contributed abundantly and meritoriously to our knowledge of the history of mammalian life in North America

But, for some years it has been growing more and more evident that it was time that an inventory should be made of what we know. And this has now been done ably by Professor Osborn in this voluminous work of more than six hundred pages. That there is no place in the world where such a work could be written as the American Museum of New York City, with its extensive collections, and various experts in paleontology, especially Dr. Matthew, for aid and advice, vertebrate paleontologists know full well. That there is no one who could treat the subject more broadly and comprehensively than Professor Osborn will, also, be as readily admitted. Indeed there are few who are competent to criticize expertly the work as a whole, as the reviewer is painfully conscious, since he knows that he is not one of them. Vertebrate paleontology has advanced with such enormous strides within the scientific career of the present writer even, that it is no longer possible for

any one to be expert in more than one of its half dozen branches. But the writer does appreciate the merits of the work, since it will relieve him, in large part, as also many others, of the almost insurmountable difficulties he has encountered in attempting to keep abreast of the discoveries in mammalian paleontology.

In brief, the work deals with extinct faunas, rather than with the evolution of mammals, with "time and place" rather than with "descent", as the author says, it is "a study of the sources or birthplaces of the several kinds of mammals, of their competitions, migrations, and extinctions, and of the time and places of the occurrence of these great events in the world's history." As such, after the introduction, of which more later, it deals with the faunas of each great division, and its minor subdivisions, so far as possible, of the Cenozoic, geologically, geographically, environmentally and faunistically The author makes use of whatever available assistance is afforded by other branches of paleontology in his paleogeographic and climatic discussions, though not always with the same expertness that he shows in his more special field of research, the mammals, as for instance, the statement on page 106 that *Helagras* is the oldest known American serpent. Marsh years ago described the serpent *Coniophis* from the Lance beds, and the present writer can confirm his determination, and he also objects to calling *Champsosaurus* either aquatic or a lizard But the few such errors that the writer has observed are trivial, and it would be supererogatory to search for others

To give even a résumé of the work would be beyond the limits of this article Perhaps no part, other than the introductory chapter, will be of more general interest than that dealing with the Pleistocene, and especially that with man in his faunal and time relations. The writer is one who still believes, notwithstanding the objections raised by geologists and anthropologists, that there is paleontological evidence of man's contemporaneity in North America with some, at least, of the extinct mammals, and he finds of interest the summary of such evidence.

By the aid of sections, maps and photographs every known horizon of the North American Cenozoic yielding vertebrate fossils is located and defined, and correlated, so far as possible, with the horizons of other lands For the American deposits and faunas, and to a very large extent for those of other lands, the data of this work have been brought together from original sources, and the writer has sufficient acquaintance with the literature to perceive that very few indeed have been omitted or overlooked The numerous figures of skeletons, and photographs of restorations chiefly from the able brush of C R Knight, will especially commend the work to the general reader. Many of these figures have become familiar to students within recent years in special works and in texts They are here brought together and numerous others added

Not the least useful part of the work to the zoologist is the summary of the classification of the Mammalia in the appendix, with a list of the known genera, their range and distribution That it will be accepted immediately by zoologists in its entirety is hardly probable The writer for one, as a student of the extinct reptiles, demurs at the unreserved location of the Multituberculata among the Marsupialia, notwithstanding the apparently convincing discoveries of Gidley *Tritylodon* stands, confessedly, somewhere near the dividing line between the Reptilia and Mammalia, and the relationships between *Tritylodon* and the Multituberculata seem so clear that one can not accept the necessary conclusion that the reptiles evolved directly into marsupials That some or all of the Multituberculata will some time be proved to be oviparous the writer firmly believes, and there are others who believe so with him. The author accepts not less than thirty-four orders of Placentals, arranged under four chief groups, the Unguiculata, Ungulata, Primates and Cetacea. We need to add but three or four more "cohorts" of equivalent rank—and the author may rest assured that some of his zealous colleagues will promptly do so—and we again have essentially the older classification under new names. There is a similar

tendency in all branches of natural history, and the writer deplores it. Is it not just as well to call these chief groups orders with as little disturbance as possible to existing plans of classification? For, after all, it seems to be merely a question of names. However, classification of organisms is an art that passes understanding, and no one knows where it will end, possibly when all the species have been raised to genera and all the genera to families, and families to orders, etc.

Perhaps the most widely useful part of the work is reserved for the conclusion of this review—the introductory chapter. In this the author brings together in a readable way the underlying principles of paleontology, with especial reference to mammals, but also widely applicable, not only to all branches of paleontology, but to all natural history as well. The philosophy of structure, correlation, range, environment, the laws of evolution as applying to mammals in general and in detail, are among the subjects treated. Not all is discussed that might have been, not all the conclusions are beyond controversy, but, withal, it is the best summary of the guiding principles of paleontological research the writer has seen.

The writer can not recommend the work as one suitable to slip into one's grip for literary recreation on a vacational outing—it is a little heavy and forbidding in places. As a work of reference for the geologist and naturalist it is indispensable, and it will be a working tool for the student of extinct mammals. Perhaps, with the publication of this work there will no longer be an excuse for the further display of the dense ignorance concerning extinct forms that characterizes the most of our text-books in zoology—at least let us hope so!

In conclusion it may be said that this inventory of extinct mammals has been well done, the way is again cleared for a further rapid expansion in our knowledge of this class of vertebrates. And the author is to be commended and congratulated on the opportunities he has aided in opening up.

S. W. Williston

Catalogue of the Nearctic Hemiptera-Heteroptera. By Nathan Banks. Philadelphia, Pa., American Entomological Society. 1910.

This catalogue covers the entire group of Heteroptera for the Arctic region, and in this respect is of much greater service to the American student than the general catalogue of Kirkaldy which includes only a few of the families represented in this region. The work is rather a presentation of the existing knowledge than an attempt to rearrange the grouping or to introduce radical changes in the generally accepted nomenclature. The list covers 1,268 species and is particularly serviceable in certain families which have not been treated in recent years. Such a catalogue has been much needed, as the only work of a similar character, the list by Dr. Uhler, published over twenty years ago, is long since out of date. The paper shows some defects in proof reading, as for instance, the misspelling of *Macrovelia* and *Zicrona*, but on the whole it seems to be quite free from serious error. We can certainly share with the author the hope "that this catalogue will encourage entomologists to devote more time to this order, so that our forms will be better known to us."

Herbert Osborn

The Relation between Chemical Constitution and some Physical Properties. By Samuel Smiles, D.Sc., New York, Longmans, Green and Co. 1910.

The study of the relations between the chemical constitution and the physical properties of substances has interested chemists and physicists for a greater period of time than has the study of any other branch of chemistry which possesses more or less general interest at present. For this reason, the volume under review should exert a wider appeal than any which have appeared in the series of "Text-books of Physical Chemistry" edited by Sir William Ramsay, of which it forms a part. As part of a physical chemistry series it will appeal to physical and inorganic chemists, and it will also appeal to organic chemists, since as stated by Professor Smiles

in the preface, it has been written "from the standpoint of organic chemistry"

The subject matter is discussed under the following headings. Mechanical Properties, under which are treated Capillarity, Viscosity and Volume Relations, Thermal Properties, including Specific Heat, Fusibility and Boiling Point, Optical Properties, including Refractive and Dispersive Power, Absorption of Light, Fluorescence and Magnetic Rotatory Power, and Electric Property, including a short chapter on Anomalous Electric Absorption

In an introductory chapter, the development of the study of the physical properties is traced and the gradual increase in importance of these properties as aids in determining chemical constitution is clearly brought out. The concluding statement of this chapter that in determining chemical constitution "evidence drawn from physical properties should be regarded as subordinate to chemical evidence" will be concurred in by most chemists. In the sections dealing with the Mechanical and Thermal Properties, an unsatisfactory impression is obtained at times with regard to the scope of the theoretical treatment as well as the application to the experimental data On the other hand, in fairness to the author, it must be said that with the space at his disposal a more satisfactory treatment of these subjects is scarcely possible The same criticism does not apply to the chapters in which the optical properties are discussed, as here the treatment is clear and complete, especially in describing the relations which have been deduced between absorption and chemical constitution The additive and constitutive effects exerted by the atoms and groups of a molecule upon each property are carefully distinguished throughout and illustrated by concrete examples

The concluding chapter considers the present status of the subject and the most fruitful lines for further investigations In the opinion of the author, the study of the optical properties, including absorption and refraction, offer the greatest promise, but further advance along these lines depends upon a satisfactory theory of valence This, it is pointed out, is the most important problem awaiting solution from the chemist, and "the electronic theory seems to be the only means by which there is any prospect of attaining further knowledge of the nature of valence"

K. G FALK

Chemische Krystallographie By P VON GROTH Leipzig, Wilhelm Engelmann. 1910. Vol 3 Pp iv + 804, 648 figures; 8vo, cloth, 30 Marks (Volume IV is in preparation)

In 1904 Professor P von Groth, of the University of Munich, published his "Einleitung zur Chemischen Krystallographie," and followed it two years later with the first volume In 1908 the second volume of the "Chemische Krystallographie" was issued These volumes have all been reviewed in SCIENCE[1]

Groth's "Chemische Krystallographie" is a work of monumental proportions, and is to include the crystallographic data of all substances which have been described at the time of the publication of the individual volumes Inorganic compounds were discussed in volumes I and II The third and fourth volumes are to be devoted to organic compounds. In volume III, which has just been published, crystallographic data are given for the aliphatic carbon compounds, hydrobenzol derivatives and terpenes The method of treatment in this volume is the same as in the others, according to which all substances having a similar chemical composition are placed together and their descriptions prefaced by a discussion of the work done on the group. These discussions are suggestive as well as critical in character and make the work of much more value than a mere compilation of chemical crystallographic data could be. This volume, as well as volume IV, which it is hoped will be published before long, ought to prove of especial value to organic chemists.

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[1] Vol XXV., 143–144; Vol XXVIII, 343

DO FERNS HYBRIDIZE?

IN a paper entitled "Physiological Aspects of Fertilization and Hybridization in Ferns,"[1] Dr. W. D. Hoyt gives considerable space to the evidence heretofore brought forward to prove hybridity among ferns. After considering the evidence under three headings, viz., (*a*) characters of the mature sporophyte, (*b*) experiments in which prothallia of different species have been grown together and some of the resulting plants have been considered intermediate, (*c*) experiments in which sperms of one species have been presented to eggs of another species, and their behavior watched, he concludes that the affirmative evidence is entirely insufficient, and that the only evidence which is worthy of consideration is negative. He also adduces what he considers additional negative evidence based on his study of the behavior of the gametes of certain ferns with which he worked.

Dr. Hoyt's paper deserves consideration for its physiological features. His experiments and observations as to the behavior of the sperms and the fusion of the gametes are extremely interesting. Unfortunately, however, the paper does not deserve serious consideration with respect to his conclusions regarding the evidence as classified under the first two headings. His conclusions on these points carry no weight whatever, because they are not based on a first-hand knowledge of the facts concerned.

For example, in order to be sure of the identity of the common ferns with which he worked, such as *Dryopteris Thelypteris*, he felt obliged to send his material to Mr. W. R. Maxon for identification. What weight then can his opinion carry with regard to what forms constitute reasonable variations of these common species and what forms are so different as to deserve a specific if not a hybrid rank? Dr. Hoyt's work with fern hybrids suggests the story which is told of a certain (or rather uncertain) investigator of the embryology of a species of *Pinus* who did not know the tree in life. Moreover, when Dr. Hoyt was beginning his study of this particular problem at the New York Botanical Garden, he did not even care to examine ample material of nearly all the reputed hybrids of *Dryopteris*, although he was offered every opportunity to do this. Apparently his mind was already made up on this point. He wished only to see the experimental plants which Miss Slosson produced by planting in pairs unisexual portions of the prothallia of *Dryopteris cristata* (L.) Gray and *D. marginalis* (L.) Gray, and *Asplenium platyneuron* (L.) Oakes and *Camptosorus rhizophyllus* (L.) Link, respectively. The fact that these experimentally produced plants are identical with the wild plants described as the hybrids of these pairs of species, Dr. Hoyt explains easily by suggesting that all may be mere variations. If he had known well the parent species and the reputed hybrids, he could not have made such a suggestion. Either there are hybrids in *Dryopteris*, et al., or else there are a considerable number of undescribed new species.

The third class of evidence is the only kind of which Dr. Hoyt has any adequate knowledge, and even here his unfamiliarity with the wild plants has reduced to a vanishing point the negative value of that which he presents. Thus he cites as the main evidence which he offers to disprove hybridity among ferns, the fact that he was unable to cause fusion between the gametes of two species which no one has ever suspected from field study to be in the habit of crossing, *i. e.*, *Dryopteris Thelypteris* (L.) Gray and *Dryopteris noveboracensis* (L.) Gray. Sixty-seven attempts he records as having been made to secure the fusion of an egg of one of these with the sperm of the other, but, as he observes, most of the eggs "looked bad," that is, incapable of fertilization, so that his main conclusion rests on a few attempts to cross two species which a knowledge of the wild plants would have warned him not to use. It is to be regretted that he did not try to cross *Dryopteris cristata* with *Dryopteris marginalis*.

He reports four negative attempts to cross *Asplenium platyneuron* (L.) Oakes with *Camptosorus rhizophyllus* (L.) Link, between

[1] *Bot. Gaz.*, 49: 340–370, 1910.

which a natural suspected hybrid is known, a duplicate of which Miss Slosson produced culturally Most of his experiments at crossing were made with species in unrelated genera, *e g*, *Pteris* and *Athyrium*, two genera belonging in entirely different tribes. Also, he cites as the best evidence previous to his paper the work of O Voegler, who was unable to obtain fusion between the sperms and eggs of several pairs of unrelated fern genera, some of them genera from very distinct families, *e. g*, *Ceratopteris* and *Dicksonia*, *Dicksonia* and *Nephrolepis*, et al.

The case, then, for fern hybrids, stands just where it did and is based on facts which require reasonable explanation The evidence favoring hybrids has been fully presented, and does not need recapitulation It is quite true that experimental proof of the kind attempted by Hoyt and Voegler is lacking. No one has ever observed the development of a suspected hybrid from before the period of fusion of the gametes But such evidence is not usually required in cases of reputed hybridity. The arguments advanced by Mr. Hoyt against fern hybridity apply with practically equal force to most cases of accepted hybridity among flowering plants and in animals.

In conclusion, then, these reputed fern hybrids possess in all respects the characters generally recognized as characteristic of hybrids The existence of these plants demands some explanation, and their identification as hybrids furnishes the simplest and most reasonable one yet offered

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THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE AND AFFILIATED SOCIETIES
SECTION B—PHYSICS

THE annual meeting of the American Association for the Advancement of Science, Section B, Physics, was held in the physical laboratory of the University of Minnesota, at Minneapolis, December 28–30, 1910 It was a joint meeting with the American Physical Society Three forenoon and three afternoon sessions were held Of these, two were "general interest" sessions, in charge of the officers of Section B and four were occupied with the reading of research papers, in charge of the American Physical Society.

The presiding officers were Dr E B Rosa, vice president of Section B, and Professor Henry Crew, president of the Physical Society At a short business session of Section B Professor O M Stewart was elected a member of the council, Professors A Zeleny and K E Guthe members of the sectional committee and Professor G W Stewart a member of the general committee

All sessions were held in the lecture room of the Physics Building of the University of Minnesota The dinner on Thursday evening with the mathematicians and engineers at the Commercial Club was a very pleasant and enjoyable occasion.

The officers for the next annual meeting, to be held in Washington during the convocation week of 1911–12, are as follows

Vice president and Chairman of Section B—Professor R A Millikan, University of Chicago.

Retiring Vice president—Dr Edward B Rosa, Bureau of Standards, Washington

Secretary—Professor Alfred D Cole, Ohio State University, Columbus

Members of the Sectional Committee—E B Rosa, R A Millikan, A D Cole, K E Guthe, A P Carman, G F Hull, E L Nichols, A Zeleny

The address of the retiring chairman of Section B, Dr L A Bauer, was given Thursday afternoon on the subject "The Broader Aspects of Research in Terrestrial Magnetism" This was a joint session with Section D, whose vice-presidential address was delivered at the same time by Professor J F Hayford, on "The Relation of Isostasy to Geodesy, Geology and Geophysics" The former of these addresses is presented in full in SCIENCE, January 13, 1911, and the other will be published soon

At the other general interest session the following program was presented

"Recent Advances in Phosphorescence and Fluorescence," Professor Edw L Nichols, Cornell University

"The Isolation of Ions," Professor R. A Millikan, University of Chicago.

"The International Electric Units" (report on changes to go into effect January, 1911), Dr E B Rosa, Bureau of Standards, Washington

"Osborne-Reynolds's Theory of Gravitation," John Mackenzie, M.E, Minneapolis

Abstracts of three of these papers follow (That of Professor E L Nichols will probably appear in the next issue)

The Isolation of Ions: Professor R. A. MILLIKAN.

This paper presented the methods used and the results obtained thus far in the work on the properties of isolated ions. It contained a more complete discussion of the material which was summarized in the issue of SCIENCE of September 30, 1910, and in addition new results obtained in collaboration with Mr. Harvey Fletcher—(1) on the question of valency in gaseous ionization, (2) on the causes of the irregularities obtained by Ehrenhaft in Vienna in his recent work on *e*. The new work only is here briefly summarized. The tabulated experimental data upon which the conclusions rest are soon to be published elsewhere.

1. In the work previously published it was conclusively shown that the great majority of atmospheric ions carry the elementary electrical charge, but there seemed to be some evidence that ions of larger valency were occasionally formed. This evidence was found in the fact that an oil drop suspended in a strong electrical field would occasionally catch, under the influence of radium, two or three elementary charges at once *when the field was on*.

The only preceding evidence in favor of the existence of valency in gaseous ionization is contained in the experiments of Townsend[1] and of Frank and Westphal,[2] which seemed to their authors to establish the production of some doubly valent positive ions by X rays, but not by other ionizing agents.

We accordingly suspended minute drops of oil in an electrical field and produced a thin sheet of X ray ionization in the air just beneath the drop, but no rays were allowed to fall upon the drop itself. The drops experimented upon were positively charged and the direction of the field was such that only positively charged ions could be thrown upon them. *Although we used rays of varying degrees of hardness we found in 125 catches not one which represented the advent of a multiple charge upon the drop.* These experiments present therefore direct, definite, unmistakable proof that the act of ionization of air by primary X-rays, even when these rays are of extreme hardness, consists in the separation of one single elementary charge from a neutral molecule.

[1] *Proc. Roy. Soc.*, 80, p. 207, 1908, 81, p. 464, 1908, and 82, p. 18, 1909.

[2] *Verh. d. D. Phys. Ges.*, März, 1909, and Juli, 1909.

When β rays of radium were used as the ionizing agent it was occasionally found possible, as in the work previously reported, to catch at once upon a single drop two or three elementary charges, *provided the drops were of sufficient size, but when the drops were very small we caught only singles.* This shows we think that all of the double and treble catches heretofore observed were due to the simultaneous catching by a large oil drop of two or three ions coming from two or three different molecules rather than to the separation from a single molecule of two or three elementary charges. In other words the capture of a number of elementary charges at once upon large drops furnishes no argument for the production of ions carrying two or more elementary charges, unless similar results can be obtained with small drops, and this we never found to be the case. Since it was only in the case of X rays that evidence for valency in gaseous ionization had been previously found *the present experiments seem to remove all ground for supposing that the act of ionization of a gas ever consists in the expulsion from a single molecule of more than one elementary electrical charge.*

2. When we used oil drops of smaller radius than about .00004 cm. we found that the remarkable consistency in the successive values of the times of fall under gravity shown in the work previously published (see SCIENCE, September 30) was replaced by greater and greater irregularities as the drops became smaller and as the distance between the cross hairs was diminished. The explanation lies in the fact that the displacements due to Brownian movements become in such cases comparable with the displacements produced by gravity during the time of observation. The correctness of this explanation is proved conclusively by tables prepared by Mr. Fletcher which show that the observed distribution of "times of fall" between fixed cross hairs .07 mm. apart agrees perfectly with the distribution of these times *computed* from the theory of probability as applied to Brownian movements. These considerations offer a complete explanation of the irregularities observed by Ehrenhaft, since he used a cross hair distance of about the value mentioned above and worked with particles the radii of which were on the average about one fifth of those of our smallest drops previously reported upon.

Ehrenhaft's failure to observe Brownian movements with platinum and gold particles while he

saw them clearly with "phosphornebel" is presumably due to the fact that, the kinetic energy of agitation of all particles being the same, the *velocity* of agitation of a platinum particle would be but about one fifth of that of a particle of like size in a cloud of phosphorus despite the fact that, as shown by Einstein's formula,

$$\overline{X}^2 = \frac{RT}{N 3\pi a\mu}\tau,$$

the displacement along X in a time τ would be the same for the two particles In other words, while the "drift" of a Brownian particle is inversely proportional to its radius and *independent of its mass*, the "instantaneous speed" of a particle of given radius is inversely proportional to the square root of its mass There is then nothing whatever in Ehrenhaft's work to raise a suspicion as to the correctness of any of the conclusions which have been drawn from our observations

The International Electrical Units Dr E B ROSA

The international electrical units current in all countries throughout the world are based upon the definitions and numerical values adopted at Chicago in the International Electrical Congress of 1893, except that the numerical value of the standard cell, adopted by Germany and some other countries, was slightly different from that recommended by the congress, which latter value was legally adopted in America, England, France and some other countries In order to secure international uniformity so that the ampere and the volt, as well as the ohm, should be the same in every country, an international research was carried on at the Bureau of Standards, during April and May of last year, in which the standards of the national laboratories of England, France and America were compared and the silver voltameter was investigated. As a result of this cooperative effort, the International Committee on Electrical Units and Standards has agreed to recommend to all the governments represented in that committee the adoption of a new value for the Weston Normal cell, which has the effect of changing the numerical value of the international volt and also of the international ampere The new value of the Weston Normal cell, at 20° C, is 1 0183 The previous value in America was 1 0191, whereas in Germany it was 1 0186, and in England for the last two years it has been 1 0184 although previously it was higher than the value in this country There will be, as soon as the new value has been generally adopted, international uniformity with respect to the value of the units of resistance, current, voltage and power It will, of course, require some time before the new values come into general use, although it is expected that they will be officially adopted in all countries at an early date The Bureau of Standards adopted the new value January 1, 1911, and certificates issued by the bureau after that date will be in terms of the new units The difference is, of course, inappreciable in ordinary engineering operations, but is very important in precise measurements, and is appreciable even in photometric measurements of electric lamps, in which the voltage or current, or both, are given

Osborne-Reynolds's Theory of Gravitation Mr JOHN MACKENZIE, M E, Minneapolis

In contrast with the ordinary view that space is filled with an ether of very low density, Reynolds's view is that space is filled with a granular medium of very high density The grains are small, hard spheres The density of this medium is 10,000 times that of water The grains are usually arranged in "normal piling" Where matter exists this arrangement is disturbed and a less number of grains occupies the same space This is "abnormal piling" Matter is then negative mass. An atom of matter consists of a nucleus of grains in normal piling surrounded by a shell of grains in "abnormal piling"

The grains have motion relatively to one another, but the mean path of the motion is only a very small fraction of their diameter This motion renders the medium elastic An experiment with billiard balls was used to illustrate mass motion in space, defined as a "coming in of grains in front and leaving of grains in the rear"

To illustrate the difference between normal and abnormal piling of grains a rubber balloon filled with sand and water was subjected to pressure by placing a 75-pound weight upon it The sinking of the liquid in an attached manometer tube showed that the addition of the weight *increased* the total volume of the intergranular spaces occupied by the water.

Reynolds holds that there is no attraction residing in masses of matter, but where abnormal piling (bodies of matter) exist, the pressure of the surrounding medium tends to restore normal piling and incidentally masses are driven together. This is gravitation

The theory is also applied to the explanation of cohesion, electricity, magnetism, light and other physical phenomena.

At the joint sessions for the reading of research papers the following list was presented

"The Ratio of the Two Heat Capacities of Carbon Dioxide as a Function of the Pressure and the Temperature," A. G. Worthing, University of Michigan.

"On the Adiabatic Expansion and Porous Plug Effect in Water between 0° and 40°," John R. Roebuck, University of Wisconsin.

"The Acoustic Shadow of a Sphere, the Theory and Certain Practical Applications," G. W. Stewart, State University of Iowa.

"On the Function of Rest in Restoring a Platinum-iridium Wire to its Annealed Condition," L. P. Sieg, State University of Iowa.

"The Nature of the Recovery of Light-positive and Light-negative Selenium," F. C. Brown, State University of Iowa.

"On the Fluorescence Spectra of the Uranyl Salts and the Structure of Luminescence Spectra in General," Edward L. Nichols and Ernest Merritt, Cornell University.

"The Effect of Red and Infra-red on the Decay of Phosphorescence in Zinc Sulphide," Herbert E. Ives and M. Luckiesh, National Electric Light Association, Cleveland, O.

"Ocean Currents and Barometric Highs," W. J. Humphreys, Mount Weather Observatory, Bluemont, Va.

"Ocean Currents and Barometric Lows," W. J. Humphreys, Mount Weather Observatory, Bluemont, Va.

"The Light-emission of Tungsten, Tantalum and Carbon as a Function of their True Temperature," C. E. Mendenhall and W. E. Forsythe, University of Wisconsin.

"The Pentane Lamp as a Primary Light Standard," E. B. Rosa and E. C. Crittenden, Bureau of Standards.

"Experimental Indications of the Nature of Magnetism," S. R. Williams, Oberlin College.

"The Effect of Magnetization on the Optical Constants of the Magnetic Metals," L. R. Ingersoll, University of Wisconsin.

"The Second Postulate of Relativity," O. M. Stewart, University of Missouri.

"A Preliminary Report of Experiments on the Effect of Changes in the Pressure of Gases upon the Mobility of Positive and Negative Ions Produced by the Discharge of Electricity from a Fine Point," E. J. Moore, Oberlin College.

"The Transmission of Excited Radioactivity," Wellish, Yale University.

"The Coefficient of Recombination of Ions in Carbon dioxid and Hydrogen," Harry A. Erikson, University of Minnesota.

"A Method of Measuring the Fluctuations in a Rapidly Varying Resistance," F. C. Brown and W. H. Clark, State University of Iowa.

"The Causes of Zero Displacement and Deflection Hysteresis in Moving-coil Galvanometers," Anthony Zeleny, University of Minnesota.

"The Effect of Wave Form upon Incandescent Lamps," M. G. Lloyd, Chicago, Ill.

"Diffraction and Secondary Radiation with Short Electric Waves," A. D. Cole, Ohio State University.

"Notes on the Discharge of Electricity through Gases," G. S. Fulcher, University of Wisconsin.

"The Free expansion and Joule-Kelvin Effects in Air and in Carbon Dioxide," A. G. Worthing, University of Michigan.

"On the Temperature Coefficients of the Free and the Absorbed Charges in Electric Condensers," Anthony Zeleny, University of Minnesota.

"Terminal Velocity of Fall of Small Spheres in Air at Reduced Pressures," L. W. McKeehan, University of Minnesota.

"The Electrical Discharge between a Pointed Conductor and a Hemispherical Surface in Gases at Different Pressures," Franz A. Aust, University of Minnesota.

"The Effect of Distance upon the Electrical Discharge between a Point and a Plane," O. Hovda, University of Minnesota.

"A Lecture Electroscope for Radioactivity."

"A Variable High Resistance of India Ink on Paper," Franz A. Aust, University of Minnesota.

"The Electrical Discharge from Liquid Points," John Zeleny, University of Minnesota.

"A Microscope Plate Micrometer," John Zeleny and L. W. McKeehan, University of Minnesota.

"A Kinetic Theory of Gravitation," Chas. F. Brush, Cleveland.

"On a Variation in the Intensity of the Penetrating Radiation at the Earth's Surface observed during the Passage of Halley's Comet," Arthur Thomson, University of Toronto.

"On the Resolution of the Spectral Lines of Mercury," J. C. McLennan, University of Toronto.

"Infra-red Gratings," C. F. Brackett and A. Trowbridge.

"The Question of Valency in Gaseous Ionization," R. A. Millikan and Harvey Fletcher.

"A Probable Explanation of the Irregularities obtained by Ehrenhaft and Przibram in their Work on the Value of the Elementary Electrical

Charge," Harvey Fletcher, University of Chicago

"Note on a Form of Spectrophotometer," Edward L. Nichols and Ernest Merritt, Cornell University.

A. D. COLE,
Secretary, Section B

SECTION G—BOTANY

AT the convocation week meetings in Minneapolis, Section G held two sessions, one on Wednesday afternoon, December 28, and the other on Friday morning, December 30, under the vice presidency of Professor R. A. Harper. Dr. William Crocker served as secretary in the absence of the regular secretary, Dr. Henry C. Cowles. The customary address of the retiring vice president was necessarily omitted, owing to the death of Professor Penhallow. The program consisted of four special addresses and a number of technical papers, abstracts of which appear below.

The section unanimously adopted the following resolution regarding the death of Vice president Penhallow: The botanists of the American Association for the Advancement of Science note with sorrow the absence from our meetings of David Pearce Penhallow, long a member of the association and a year ago the vice-president for the Section of Botany. We shall miss his tall impressive figure, his kindly voice and his keen and discriminating discussion. We here inscribe upon the minutes of the Section of Botany this tribute to his worth, and request the council of the association to make an appropriate entry upon its record.

Upon motion of Professor Newcombe, it was unanimously voted to request the council to appoint a committee to investigate the conditions for research in the Bureau of Plant Industry.

The following officers were chosen:

Vice president—Professor F. C. Newcombe.

Member of the Council—Professor F. C. Newcombe.

Member of the Sectional Committee (five years)—Professor L. H. Pammel.

Member of the Sectional Committee (one year, to fill the vacancy caused by the death of Professor Barnes)—Professor L. R. Jones.

Member of the General Committee—Professor C. E. Allen.

SPECIAL ADDRESSES

Imperfect Fungi as Causes of Wheat-sick Lands and of Deterioration in the Quality and Yield of Wheat: H. L. BOLLEY (abstract below).

The Organization of the Fruit-bodies of Hymenomycetes: A. H. REGINALD BULLER.

A Summary of Ecological Results from Colorado. FREDERIC E. CLEMENTS.

A South Sea Botanical Trip: JOSEPHINE E. TILDEN.

ABSTRACTS

The Work of Imperfect Fungi in Cereal Crop Deterioration. HENRY L. BOLLEY.

This paper gives an outline of experiments conducted at the North Dakota Agricultural College, dealing with the relation of the imperfect fungi in cereal cropping.

The essential conclusions may be summarized about as follows: the soils of the older wheat areas of the northwest are in the same sort of sanitary condition as the old flax cropped lands and may quite properly be spoken of as wheat-sick or wheat tired in the same sense as has previously been shown for flax lands. Wheat and other cereal lands are not necessarily depleted chemically as indicated by many agricultural and chemical writers, but may be only incapable of producing proper yields because of poor sanitary conditions in the soil or in the seed.

Soil and seed born diseases have been and are the agents which vitiate the conclusions of many well planned schemes of agriculture, as, for example, in fertiliser trials and crop rotations. These diseases, in large measure, account for the types of soil deterioration which agriculturists have had largely under discussion, much of the supposed improvement which has been described by such writers as applicable to special systems of cropping and of soil fertilizing have, in large measure, been due to bettered sanitary conditions rather than especially improved conditions as to soil fertility.

The genera of fungi which have been worked out as destructive to flax, wheat, oats and barley are found to belong to the old group of *Fungi imperfecti*. Of these the chief ones are *Helminthosporium*, *Colletotrichum*, *Fusarium*, *Macrosporium* and *Alternaria*.

There may be several species of each of these different genera at work. By cross infection, it is found that some of the kinds which attack wheat also attack barley. It is particularly interesting to note that practically all of the kinds which attack wheat also attack quack-grass. This accounts in large measure for the destructive influences which quack-grass has upon the development of the young cereal crop over quack grass areas.

Chief among the lines of work which have en-

abled the investigators to arrive at definite conclusions, has been the development of a disease propagation garden whereby the struggle for existence of the crop plants against great odds has been carefully noted and the attacking plants observed

In summarizing, attention is called to the bearings of these findings upon agriculture and upon the various lines of investigation Proper consideration of sanitary methods of handling soil and seed will prove a great boon to cereal crop growers but in order to accomplish this, it may be necessary to rearrange the methods of fertilizing soils and our systems of crop rotations These observations regarding the persistence of disease in the seed and in the soil will, of necessity, materially change our ideas as to why one crop does better after than before some other crop These observations, it is thought, explain many of the anomalies of farm cropping why certain methods of manuring result in shrivelling of seed wheat, why the attacks of rust are so destructive, why proper seed treatment has always resulted in better yields than could be explained by the presence or absence of smut alone, why the corn crop has proved to be such a beneficial crop to precede wheat, etc

In closing, attention is called to the extensive work of the Bureau of Soils of the Department of Agriculture upon so-called toxins in the soil, the troubles which they describe may not, of necessity, rest primarily in the soils Before material progress is made in the amelioration of conditions of cereal agriculture, proper consideration of soil and seed sanitation will prove to be the center about which great modifications in our present methods of agriculture must be shaped

The Succession of Vegetation in Ohio Lakes and Ponds ALFRED DACHNOWSKI.

Along the line of "watersheds" in Ohio are a number of lakes and ponds in various stages of "filling" Almost throughout, the surface vegetation is one that is common to bogs In relatively undisturbed areas there is a zonal arrangement An attempt is made at a classification of the formations, and a formulation of the laws of succession involved in the comparative study.

Forest Dynamics on Isle Royale, Lake Superior WILLIAM S COOPER

The dominant forest of Isle Royale is composed mainly of three tree species—balsam fir, paper birch, white spruce The relations of these to each other are as follows Spruce and birch form a small proportion of the forest if all ages are considered, but a large proportion of the mature stand The few large trees of these species are very conspicuous, while young ones are hard to find Balsams of all sizes, especially small, are exceedingly numerous The appearance is therefore of rapid succession, the balsam succeeding the other species.

Quadrat studies of selected areas, with the ages of all trees in the quadrats determined, shows that this appearance is deceptive The forest as a whole is in equilibrium, but a given area is continually changing in composition and in the relative proportions of the different tree species The changes are due primarily to the fact that all three species require considerable light during their early stages One generation in a given area prevents reproduction until maturity or some accidental cause brings about its destruction Windfall, by allowing light to reach the ground, is the commonest cause of the beginning of a new generation In windfall areas young tree growth soon springs up, usually predominantly balsam, owing to the ready germination of this species Balsam never becomes predominant in the mature stand, in spite of high reproduction, because of high mortality The reproduction of birch and spruce is low, but their mortality is also low

The result of these processes is that equilibrium is maintained in the forest as a whole The dominant forest is therefore the Climax Forest of the island

Observations on the Underground Stems of Symplocarpus and Lysichiton · C O ROSENDAHL

The underground stems of *Symplocarpus fœtidus* and *Lysichiton camtchatcense* are true sympodia, although the fact is not readily perceived on account of their thickness They grow very slowly, adding only from 3–8 mm. to their length yearly

On full-grown plants, five to six renewal shoots, or joints, of the sympodium are produced each year In *Symplocarpus* each renewal shoot or joint bears two foliage leaves, a spathe and an inflorescence. In *Lysichiton* each joint bears in addition two bracteal leaves, and the last 1–3 leaves in the fall are much reduced foliage leaves, *i e*, green leaves with very small laminæ, in *Symplocarpus* the first 2–3 leaves to appear in the spring are scale leaves

Symplocarpus sends up and matures only 1–2 inflorescences a year. The others become arrested and remain in between the broad bases of the foliage leaves *Lysichiton*, on the other hand, matures from 2–4 inflorescences yearly

The habit of these two aroids in producing from 2–5 inflorescences in excess of the number they are capable of maturing each year is to be explained in the light of their tropical origin and in their previous more southerly range

Some Effects of Severe Freezing upon Vegetation in a Condition of Active Growth F K. BUTTERS and C. O. ROSENDAHL

On the night of April 15, 1910, the temperature at Minneapolis fell to 27° F, and a week later to 19° F with a high wind At the time of these frosts vegetation was in an advanced state, many trees were in full leaf, and nearly all others in active growth Observations were made upon about seventy species of woody and herbaceous plants It was found that besides the injury due directly to cold, much mechanical injury resulted from loss of turgidity in succulent young shoots during the early stages of freezing, and from the extreme brittleness of hard frozen leaves and twigs which the wind snapped off in great numbers The second freeze injured many plants which were not hurt by the first one About 42 per cent of woody species lost practically all their foliage, only about 10 per cent were relatively uninjured Mature leaves and those just unfolding from the bud were less injured than half-grown leaves of the same plant In about 60 per cent of the species the twigs of the new growth were killed or severely injured In about 15 per cent the twigs of the past season's growth, and in a few instances older twigs, were injured Flower buds were somewhat more tender, open flowers and fruits much more tender than vegetative parts Damage to native herbaceous plants was mainly mechanical, and relatively slight except in the case of open flowers and fruits A few weeks afterwards herbaceous vegetation appeared normal while woody plants had just begun to recuperate The most usual types of recuperation in trees and shrubs were (1) when the twigs were uninjured and the terminal bud intact, this often made a further growth bearing a new crop of leaves, (2) when the outer parts of the new twigs were destroyed while the basal parts remained intact, lateral shoots often arose from the leaf axils of these uninjured portions either with or without the intervention of scaly buds, (3) many latent buds started into growth upon the woody twigs, sometimes upon those several years old In some cases all these methods of recuperation appeared in the same plant.

Color Photography in Botanical Work. FRANCIS RAMALEY

Botanists can make use of the new color photography especially in studies of ecology and plant breeding Many features of vegetation are brought out much more clearly than by ordinary photography Thus, a moor with scattered shrubs or a lake-margin surrounded with belts of different plants can be well shown In plant-breeding experiments the appearance of the different hybrids and extracted forms can be reproduced with much faithfulness Colored plates from books are easily reproduced upon lantern slides The exposure required is about 200 times that for an extra rapid isochromatic plate Hence no "snap shots" can be taken, but if the light is good there need be no difficulty in securing good results Development can be carried out in an ordinary dark room The solutions used are inexpensive and easily prepared

Respiration (CO_2 Production) in Air, in Nitrogen and in Hydrogen B M DUGGAR and GEORGE R HILL, JR

The experiments reported give data respecting the rate, continuance and decline of anaerobic respiration (CO_2 production) in nitrogen and hydrogen as compared with aerobic respiration under otherwise similar conditions The plant materials used were slices of sugar beet and germinating seed Special attention is also drawn to the importance of an available nitrogen supply for other physiological purposes

The Flora of the Olympic Peninsula, Washington ALBERT B REAGAN

The Olympic peninsula in northwest Washington comprises a wide coastal strip bordering on the Pacific Ocean, the Strait of Juan de Fuca and Puget Sound, surrounding a totally isolated, central high area termed the Olympic Mountains These occupy an eroded domed area in the east central part of the peninsula, with a western limb extending in declining altitude to Cape Flattery The peaks in the central area range from 6,000 to 8,150 feet in height, Mount Olympus being the highest peak The domed surface causes a radial drainage in all directions, but the larger streams flow into the Pacific

This peninsula with its lofty peaks stands first in the path of the moisture-bearing southwesterly winds from the Pacific, hence the precipitation is great, at the coast it is usually rain, in the mountains snow The precipitation averages 40 inches north and east of the mountains; west of the mountains at an elevation of 3,000 feet, about 80 inches; and in the Pacific and upper-Strait-Flattery region, 100 to 1?0 inches The climate,

also, is controlled by the prevailing warm winds from the western ocean, at the coast line snow is seldom seen

Under such an equable climate and abundance of rainfall, the peninsula, with few exceptions, is the most densely forested region in our country, and smaller plants do equally well Of course as one approaches the mountains the forest becomes less dense till the timber line is reached, but in the reverse proportion the flowering herbs at the same time increase in number and beauty The region in the lower levels is a jungle of trees, shrubs and entangled vines

About 200 square miles of the timbered area has been burned over, 260 square miles is naturally timberless, lying just at timber line; and 150 square miles consist of ice and rocks

The most conspicuous plants of the peninsula are red fir (*Pseudotsuga taxifolia*), lovely fir (*Abies amabilis*), subalpine fir (*Abies lasiocarpa*), white pine (*Pinus monticola*), red cedar (*Thuja plicata*), Alaska cedar (*Chamæcyparis nootkatensis*), Sitka spruce (*Picea sitchensis*), Merten's hemlock (*Tsuga Mertensiana*), vine maple (*Acer circinatum*), maple (*Acer macrophyllum*), alder (*Alnus oregona*), cottonwood (*Populus trichocarpa*), dogwood (*Cornus Nuttallii*), thimble berry (*Rubus parviflorus*), salmon berry (*R. spectabilis*), raspberry (*R leucodermis*), red elderberry (*Sambucus callicarpa*), red huckleberry (*Vaccinium parvifolium*), salal (*Gaultheria shallon*), Oregon grape (*Berberis nervosa*), fireweed (*Epilobium spicatum*), bracken fern (*Pteridium*), blue huckleberry (*Vaccinium ovalifolium*) and devil's club (*Echinopanax horridum*)

Of the plants of the region, the most conspicuous are the forest trees, which here reach gigantic proportions. Principal among these are fir, spruce, hemlock and cedar ranging from 200 to 400 feet in height, 90 feet clear of limbs, and from 10 to 13 feet in diameter, or more (the cedars ranging from 30 to even 50 feet in some instances) Intermingled with these trees is a profusion of shrubbery so dense in the coast districts that it is difficult to traverse the region. The estimated timber aggregates more than 70,000,000 M feet B.M., or enough timber to supply the entire United States's demand for more than two years.

The plants so far identified in the peninsula number 689

Twin Hybrids in Œnothera, with a Suggestion concerning their Explanation: R. R. Gates.

A large number of crosses were made, confirming in general the type of behavior in *Œnothera* called by de Vries twin hybrids, and adding new crosses which have not previously been made When a member of the *Onagra* group of species of *Œnothera* is pollinated by *O Lamarckiana* or one of its mutants, two types are produced known as *læta* and *velutina*, the former having broad and smooth leaves, the latter narrow, furrow-shaped and hairy leaves These types resemble each other in the different crosses, and both usually breed true There is a similar dimorphism in cultures of *O lævifolia*, broad leaved and narrow-leaved types occurring In cultures of forms which probably belong to *O muricata* (having smaller flowers than *O biennis*), from wild seeds collected in Nova Scotia, at St John, N B, and at Winnipeg, a similar dimorphism is found to occur, *i e*, broad leaved and narrow-leaved types, although the races do not all agree in other particulars The Winnipeg plants came from seeds of one individual. There is therefore a marked dimorphism of some of the forms in the wild condition, and this may account for the occurrence of similar twin types in crosses in which *O biennis* is the female parent, the condition being transmitted in the eggs, but not usually through the pollen.

The Sand-dune Flora of Iowa. B. Shimek

A discussion of the distribution and the physiographic features of the limited dune areas of the state is given The flora of the sand dunes is presented and the fact is brought out that while a limited number of species may be considered as characteristic of the dunes, the greater part of the flora is identical with that of the drier prairies

On the Relation of the Living Cells to Transpiration and Sap-flow in Cyperus: James Bertram Overton.

Experiments in which cut stems of *Cyperus* are placed in water show that withering occurs sooner than when a certain portion, not to exceed 20 cm., has been killed with steam and the killed stems left in connection with the roots When 20 cm. of the stem are killed with steam the leaves wither in about eight days, or in about the same time as control plants. It has been found that the longer the portion killed by steam the sooner the leaves above wither and dry When 25–30 cm. of the stem are killed with steam, the leaves wither in three to five days, no matter how long the section killed with steam may be. The leaves on steamed stems never wither quite so quickly

as those on stems cut and placed in water, but under the same conditions of light, temperature and air moisture. In this plant sufficient water to keep the leaves turgid for three to eighteen days will rise through a stem 15–60 cm high, with a section 5–60 cm. long killed with steam Experiments show that a certain amount of water is raised through the steamed portions, but that it gradually diminishes in quantity from day to day, until the leaves become air dry The diminished water supply is partly due to a partial blocking of the vessels with a gum-like substance, which probably owes its origin to the disorganization of the contents of the sieve tubes caused by heating the stems The withering of the leaves above the steamed portion is probably caused by the action of deleterious substances introduced into them from the dead cells more than from lack of water The poisonous substances are probably disorganization products caused by steaming the stems The withering leaves above a steamed portion of the stem show all of the symptoms of dying, namely, rapid loss of water directly after treatment, then a more uniform loss, rounding up and discoloration of the chloroplasts and contraction of the protoplasts The leaves apparently die, not so much from lack of water supply, as on account of the death of the cells from other causes It is evident from experiments that the steaming method of killing portions of the stems is not a satisfactory one in order to settle the question of the relation of the living cells to sap flow Other methods have been used. Killing a portion of the stem by applying wax heated to 110° C. causes less apparent disorganization of the cells of the stems, less injury to the leaves above and does not cause a marked immediate decrease in the amount of transpiration

An Undescribed Type of Elodea Flower: Robert Bradford Wylie

An unusual (and apparently undescribed) type of staminate flower was collected by the writer from East Okoboji Lake, Iowa, during the summers of 1909 and 1910. In this strain, which occurs abundantly in the locality, the axis of the staminate flower elongates rapidly at maturity, pushes out of the spathe and carries the pollen-bearing flower to the surface of the water, where it opens still attached to the plant. The degree of elongation may be as great as in the pistillate flower While the general appearance of the two flowers is similar, and the habits of reaching the surface of the water are biologically alike, the parts concerned are not homologous The elongated portion of the staminate flower is the axis below the floral parts, while that of the pistillate flower is the complex above the ovary in epigynous flowers called the "floral tube" In the opinion of the writer the form deserves specific rank, and the name *Philotria Iowensis* (*Elodea Iowensis*) is proposed

The Flora of a Saline Lake. M A Brannon

This report is based upon a study of Devil's Lake, situated in Benson and Ramsey counties, North Dakota It is a saline lake in the lowest portion of an inland drainage basin comprising about 4,000 square miles The lake has lowered about 14 feet within 27 years with the attendant results of receding shore line, separation of the former lake into divisions and an increase in the salinity of the water

Waves and the longitudinal and vertical currents cause thorough and rapid distribution of the phyto plankton in which representatives of the Myrophyceæ predominate

Ruppia maritima is the only spermatophyte found in Devil's Lake It grows in profusion on submerged terraces along shores protected by high land terraces

Enteromorpha prolifera, various species of *Cladophora*, and some of the Protococcales are the only Clorophyceæ found in this saline lake.

A study of ecological factors has been conducted with reference to pulsation in plant multiplication and in connection with inhibition of plants growing in adjacent bodies of sweet water.

Nodularia spumigena var *litoria* gave the following record May 29, 1910, there were three to five per cubic centimeter, August 18 there were several hundred filaments per cubic centimeter and on November 1 only two to three per cubic centimeter

This pulsation was believed to be caused largely by the increased heat The temperature readings on May 29 were 14° C, August 18 20° C and November 1 11° C. The maximum portion of the curve was coincident with increased light action and increased wave and current action of the lake.

Spirogyra and *Chara* were used in the inhibition experiments and the results indicate that loss of turgidity when immersed in saline solutions was largely responsible for the non-existence of these and other forms in Devil's Lake. *Enteromorpha* and *Cladophora* are capable of standing ten to thirteen per cent. salt solutions, according to Oltmanns, hence these forms are not inhibited

from Devil's Lake but are present in great quantities. Detailed physical and chemical experiments await further investigations, but present information does not indicate that the toxic action of salts is responsible for the Devil's Lake inhibition of plant forms growing in bodies of sweet water adjacent to Devil's Lake.

Nuclear Phenomena in the Basidium and in the Germinating Spores of Dacrymyces and Tremella: E. M. GILBERT.

The discovery of the fusion of two nuclei in the basidium and the further fact that the cells from which the basidia arise are binucleate, has made it of vital interest to discover the origin of this binucleate condition. The writer finds that the spores of certain species of *Dacrymyces* and *Exidia* are uninucleate and become in germination, successively two, four and eight celled, each cell being uninucleate. Germ tubes are then developed and a mycelium formed, the cells of which have a single nucleus. The binucleate condition does not then arise at the germination of the spore or in the young mycelium. Dangeard, Perrot and Maire find that the subhymenial cells of various forms are binucleate. The writer finds a nuclear fusion in the young basidia of *Exidia albida* and *Dacrymyces* sp. The double division of the fusion nucleus in species of *Exidia* and *Tremella* studied, suggests, in many of its features, that chromosome reduction occurs at this stage. Synapsis and diakinesis are well marked stages. The two spored basidia of *Dacrymyces* as noted by Juel and Dangeard raise an interesting question as to the method of reduction in this form.

The Organization of the Chromosomes in Carex: A. B. STOUT.

The visible structures in the resting nuclei in the root tip of *Carex aquatilis* and their behavior throughout mitosis make it plain that here the chromosomes are permanent individuals which can be identified not only in resting nuclei, but throughout the entire process of nuclear and cell division, except for a short time during the diaster stage when they are closely massed together.

The chromosomes are also arranged in a definite serial place relationship which is preserved throughout the late prophases and the equatorial plate stage. There is thus maintained throughout all stages of division a definite relative position of the chromosomes.

The spheroidal shape of the chromosomes is quite constant and uniform. There is, however, marked growth in their volume during early prophases until they reach their maximum size, which varies from 0.3 μ to 0.4 μ in diameter. This rather constant spheroidal shape facilitates the identification of the individual chromosomes throughout the various stages. At one stage in the late prophases the chain of chromosomes is tightly coiled about the nucleole.

This behavior of the chromosomes in *Carex* gives positive evidence in support of the view that chromosomes are permanent individuals with a definite and permanent relative arrangement in the nucleus.

The following papers were read by title:

The Relation of Aspergillus niger, Penicillium digitatum and other Organisms to Tannic Acid Fermentation: LEWIS KNUDSON.

Some Problems in the Breeding of Sugar Beets: C. O. TOWNSEND.

The Oxygen Minimum and the Germination of Xanthium Seeds: CHARLES ALBERT SHULL.

Evaporation Studies in the Sand Dune Plant-associations of Lake Michigan and in the Beech Forest: GEORGE D. FULLER.

Studies of Castilla Seedlings: PEHR OLSSON-SEFFER.

Some Experiments on the Colors of the California Poppy: PEHR OLSSON-SEFFER.

Some Physiological Conditions in the Culture of Spirogyra: W. D. HOYT.

On the Character of the Resin-tissue of the Araucarinæ and the Podocarpineæ: R. B. THOMSON.

The Antheridia of the Laboulbeniaceæ: J. H. FAULL.

Homothallic Conjugation in Rhizopus: FLORENCE A. MCCORMICK.

HENRY C. COWLES

THE UNIVERSITY OF CHICAGO

THE AMERICAN SOCIETY OF ZOOLOGISTS CENTRAL BRANCH

THE annual meeting of the American Society of Zoologists, Central Branch, was held in conjunction with Section F of the American Association for the Advancement of Science in Pillsbury Hall of the University of Minnesota, Minneapolis, Minn., on December 28, 29 and 30, 1910, Professor C. E. McClung, of the University of Kansas, presiding.

The committee on nomenclature appointed at the Iowa City meeting reported that it was making progress in the formulation of a plan

whereby the various zoological organizations of America can unite in an effort to influence the International Commission on Nomenclature in the direction of securing greater flexibility in the interpretation of its own rules. The committee was given power to perpetuate itself

The chair was authorized to appoint a committee whose function it shall be to recommend to the society plans for an agreement between its members regarding the form and manner of presenting papers for publication Such plans shall have for their purpose the aiding of other investigators in arriving at an understanding of the methods and conclusions of writers with the least possible expenditure of time and effort

Officers for the ensuing year were chosen as follows

President—George Lefevre, University of Missouri

Vice president—R H Walcott, University of Nebraska

Secretary-Treasurer—H V Neal, Knox College

Executive Committee—H B Ward, University of Illinois (for three years), Chancey Juday, University of Wisconsin, H W Norris, Grinnell College

The following, having received the votes of a majority of the executive committees of both branches, were elected to membership in the Central Branch Dr G W Tannreuther, University of Missouri, Dr A G Ruthven, University of Michigan, Dr R C Mullenix, Yankton College, Mr H Walton Clark, Bureau of Fisheries, Fairport, Iowa

The following are titles and abstracts of papers presented at the meeting·

Organ Inversion in Trematodes F D BARKER, University of Nebraska.

Situs inversus viscerum in varying degrees has long been known to occur in man This deviation from the normal position of organs also occurs in a number of animals such as the tadpoles, flatfishes and molluscs. Variation in the position of the genital organs or *sexual amphitypie* is very common in the trematodes From the examination of original specimens and the literature I have found this variation occurs in at least 26 different species, embracing 11 different genera of distomes and one genus of monostomes The percentage of *sexual amphitypie* varies from 3 per cent in some species to 50 per cent in others The degree of transposition of organs varies from the transposition of a single organ to that of six organs. In many cases other organs than the sexual organs are transposed, in which cases the term *situs inversus* is more applicable. Where only one or two organs are transposed this should be designated as *partial sexual amphitypie*

A number of theories as to the cause of *situs inversus* has been advanced, among which are "the preponderance of the omphalo mesenteric vein," "the persistence of the left venous trunks," "discontinuous substantive variation," "a condition essential to the existence of the organism," "inversion through sympathy"

Experimental work on incompletely separated blastomeres of the frog, sea-urchin, mollusc, etc, shows that such blastomeres give rise to twin embryos, one of which is a "mirror image" of the other This suggests the possibility that "mirror images" or *sexual amphitypie* in the trematodes may be due to the development of twin trematodes which have arisen from completely separated portions of the "germ balls" in the sporocyst or redia stages

Fuller account to be published later, place undetermined

Gametogenesis in Tænia serrata R T YOUNG, University of North Dakota

Testes and ovaries arise from undifferentiated parenchyma cells Oogonia and spermatogonia are similar in structure and appear to arise similarly No mitoses are found in the early stages of development of these cells Amitoses, while present, are too infrequent to account for the multiplication of the primitive sex cells, and it is probable, although not certainly demonstrable as yet, that increase is partly due to the development of nuclei either de novo or from chromidial extrusions from preexistent nuclei

The spermatocytes of the first order arise from the spermatogonia by an enlargement of the nucleus and the formation of a skein from its reticulum The spermatocytes fuse to form cytophores with subsequent breaking up of the skeins and commingling of the skein remnants with the cytoplasm of the latter The secondary spermatocytes arise in the cytophores either *de novo* or from the skein remnants of the first spermatocytes The spermatozoa are formed directly from the cytoplasm of the cytophores In oogenesis skeins are similarly formed subsequent to the growth period and similarly degenerate without the occurrence of later stages of mitosis at this time. As the ova are leaving the ovaries or after reaching the uterus an abortive maturation mitosis occurs, without however the appearance of polar bodies; the cell or cells which have been

occasionally interpreted as such, being yolk cells attached to the ova during or after their passage to the uterus. These observations support the view previously advanced that cytological processes in cestodes are degenerating in correspondence with the general degenerate character of these worms.

Full account to be published elsewhere

The Biology of the Sand-Hill Region of Nebraska. ROBERT H WOLCOTT, University of Nebraska

In SCIENCE for May 19, 1905, appeared a statement in regard to a faunal survey of this region which had been already inaugurated Soon after the publication of this statement, conditions arose which interfered with the further prosecution of this work, and in the five years which have intervened only occasional short trips to the region have been made During the past season, however, work was actively resumed by the collecting of water samples from the different lakes and the collection of additional data and specimens bearing on the topography and fauna of the lake region A preliminary chemical examination of these water samples shows that the lakes vary in strength of alkali, expressed in terms of CO_3 and HCO_3 ions, from 06 of a gram per liter to 1 61 grams per liter—a difference of more than 25 times The most highly alkaline of these lakes is not as alkaline as many other lakes which have been investigated in the far west, but the close proximity to one another, the exact similarity in every other respect than alkali content, and the fact that the alkalinity in the strongest of these lakes surpasses a percentage which apparently most of the forms present in the freshest lakes can not resist, seem to make it probable that the results of a careful qualitative analysis of the life of the different lakes will yield very interesting results Arrangements have been perfected whereby a party is to be maintained in the region throughout the coming summer, and it is expected that in this way a sufficient amount of material can be gathered to allow of the formal presentation of results, at least so far as certain phases of the work are concerned.

The Olfactory Organs and the Sense of Smell in Birds R M STRONG, the University of Chicago.

A report was given of a comparative study of the organs of smell in various groups of birds. Results of experimental studies of the olfactory sense in ring-doves were also described. Evidence was obtained in this work that at least many birds probably have an olfactory sense It is not likely, however, that the sense of smell is ever very keen in birds. A full account has been prepared for publication elsewhere.

Results of Breeding Experiments with Ring-Doves. R M. STRONG, the University of Chicago

Crossing experiments with white and blond ring doves were carried on during a period of five years In the first generation, the hybrids resembled one parent or the other in equal numbers. The blond hybrids were mostly males and the white hybrids were all females The original stock was found to breed true, but the blond hybrids behaved as heterozygotes A full account of the results obtained will appear later

The Cranial Nerves of Siren lacertina H W NORRIS, Grinnell College

The olfactory nerve is double. Anastomoses between the fifth and seventh nerves, general cutaneous fibers from the fifth and lateral line fibers from the seventh form a supra-orbital trunk, and similar fibers form an infra orbital trunk; from the latter general cutaneous and lateral line fibers unite with a branch of the ophthalmicus profundus to form a nerve that sends its lateral line fibers to innervate neuromasts at the end of the snout and its general cutaneous component to form an anastomosis with the ramus palatinus, between the alveolaris VII and the mandibularis V the characteristic anastomosis occurs only to the extent of a slight contact between the two nerves From the dorsal lateral line ganglion of the seventh nerve a nerve passes posteriorly to anastomose with the rami supratemporalis and auricularis X, suggestive of the condition in the Cyclostomata The rami alveolaris and palatinus arise by a common trunk from which is given off a so-called "posterior palatine" that connects with the ramus pretrematicus IX forming Jacobson's commissure The ramus communicans carries general cutaneous fibers only, from the tenth to the seventh nerve. Pretrematic rami of five branchial nerves are found. The ramus intestinalis recurrens X. is entirely motor, its usual sensory component having separated to form a distinct trunk. The hypoglossal nerve is formed from branches of the first and second spinal nerves. Full account to appear in Vol. 17, *Proceedings of the Iowa Academy of Science*, 1910.

The Innervation of the Lateral Line Organs in Amphiuma and Siren: H. W. NORRIS, Grinnell College.

Kingsbury's classification and grouping of the lateral line organs in amphibia is found to correspond in a general way to their innervation in *Amphiuma* and *Siren*, but it is evident that the external distribution of neuromasts is no exact indication of their innervation Much overlapping of groups occurs, and there appears to have taken place a considerable degree of migration of neuromasts from their points of origin. The occipital group of neuromasts is innervated not by the lateral line nerve of the trunk, as Kingsbury supposed, but by the rami supratemporalis and auricularis X The ramus lateralis VII in *Amphiuma*, contrary to the earlier opinion of the writer and of Drüner, has no connection with neuromasts The neuromasts in *Siren* have a much less typical arrangement than in *Amphiuma* Full account to appear in *Proceedings of the Iowa Academy of Science*, Vol 18, 1911, under the heading "The Lateral Line Organs of the Urodele Amphibians Distribution and Innervation"

A Review of Recent Work on the Development of the Sympathetic Nervous System ALBERT KUNTZ, University of Iowa

Poulton's Theory of the Origin of Mimicry in Certain Butterflies J. F ABBOTT, Washington University

A biometric study of the variation of the color pattern of butterflies of the two species of *Limenitis*, *arthemis* and *archippus*, captured in the same region in New York State fails to confirm Poulton's theory that the latter form has originated from the former by an expansion and migration through the agency of selection, of color patches existing in the ancestral type (*arthemis*) The selection hypothesis by itself would thus seem inadequate to explain the origin of the phenomenon.

Comparison of the Arrangement of Eggs in Nests of Japyx sp and Scutigerella immaculata · STEPHEN R WILLIAMS, Miami University.

A photograph of two specimens of *Japyx* sp guarding their eggs was shown The two egg-masses were placed, each in a cavity in decayed wood, in such a way that only a very few eggs were in contact with the substratum The rest were heaped upon these and touched nothing else in the cavity

The attending individuals died within twenty-four hours and the eggs never hatched, being attacked by fungus.

Precisely the same arrangement of the eggs is seen in *Scutigerella immaculata*, which occupies the same habitat The eggs are placed in a heap, few eggs only touching the moist decayed wood of the substratum and the rest above and around these. The female remains with the eggs to keep off fungi and animal parasites and no masses of eggs unattended by the female have hatched under laboratory conditions

When *Scutigerella* in the laboratory is unable to find a sufficiently secluded place to deposit the eggs they will be laid singly here and there. In every case, however, the single egg is fastened to the substratum as if in preparation for heaping others about it

Besides the well-known outward resemblances between *Japyx* and the Symphyla—the shape of the antennæ, the shape of the body, the presence of pairs of rudimentary legs on the segments of the abdomen—can these similar nesting habits not be considered as an additional indication of relationship?

The Vitalism-materialism Controversy · Can it be Ended? (vice presidential address) W E RITTER, University of California

On the Transition from Parthogenesis to Gamogenesis in Aphids S J HUNTER, University of Kansas

Observations on the conditions attending the appearance of the sexes in the aphid, *Toxoptera graminum*, now made continuously through four years, show that time of occurrence of sexes and attendant behavior of the agamic and intermediate forms continue as presented in a paper a year ago before the eastern branch.[1]

The problem of this year, beginning January last, was the addition of the woolly aphis to be studied under normal conditions, and an attempt to determine what bearing, if any, modifications in food supply might have on the *Toxoptera graminum* A duplicate series of experiments in charge of two careful observers were established last January under the following conditions in the laboratory. Wheat was germinated in three-inch pots and each treated continuously with—instead of water—solutions of a number of salts—seventeen in all, respectively. New pots of wheat, similarly treated, replaced those in which wheat succumbed to treatment.

Daily observations and records were made on each one of these experiments throughout the

[1] SCIENCE, N. S., Vol. XXXI., p 476, March 25, 1910.

entire year, and comparisons made with the stock growing in the laboratory. The wheat clearly showed the effect of the different treatments, but aphids did not manifest any significant change. When the sexual and intermediate forms began to appear on the regular stock in October they likewise began to appear on these experimental pots.

In the woolly aphis the agamic forms were wingless throughout the entire summer season. The first winged forms appeared September 19, and ceased to appear on December 6. The offspring of these winged forms are the true sexes. The first of these to appear was on December 25. These true sexes are wingless and in accordance with the observations of Von Baehr each female produces but one egg. All colonies do not produce winged forms and hence all colonies do not produce sexual forms. All winged forms of the woolly aphis do not produce offspring. Out of a series of nineteen isolated winged forms only eleven reproduced and those eleven brought forth twenty seven young composed of twenty one males and six females.

Thus far it appears difficult to correlate and establish external conditions which would appear to have a direct bearing on the transition from parthogenesis to gamogenesis in aphids.

In the two forms studied the sexes appear in the fall of the year and may be spoken of as seasonal. This is true also for a very large number of aphids whose behavior in this respect has been recorded by others. This naturally leads to a careful analysis of the conditions obtained at this period of the year. It is our purpose now to continue these studies throughout the next year, dealing chiefly with the questions of temperature and light.

On a Case of Parasitic Thoracopagus in a Frog: GEORGE WAGNER, University of Wisconsin.

An instance of a frog having three extra legs extending from an irregularly shaped bone overlying the sternum, the case was interpreted as representing what by students of teratology is known as an epigastrius (Schwalbe), or a parasitic epigastrius (Adami). The case is believed to be the first of its kind reported in an amphibian. A full account of it will be published later in the *Biological Bulletin*.

The Pomace Fly Bred in the Dark for 67 Generations: FERNANDUS PAYNE, University of Indiana.

The Proposed Laysan Island Expedition and Exhibit: C. C. NUTTING, University of Iowa.

The Origin of the Sex-cells in Necturus: BENNET M. ALLEN, University of Wisconsin.

The sex cells of this amphibian arise from that portion of the mesoderm which lies between the future myotome and the future lateral plate. This anlage was recognized as early in development as an early medullary plate stage, owing to the fact that it is noticeably thicker than the lateral plate region lateral to it, and that it is at the same time marked off from the anlage of the mesoblastic somites by a constriction that indicates the first point of division of the mesodermal sheet.

The mesodermal cells show very slight differences at this stage, being equally filled with yolk, and having nuclei in which I, thus far, have been unable to distinguish constant and important differences, nor has it been possible thus far to differentiate them from the nuclei of the endoderm. It is just possible that further work may enable me to distinguish them in this and in earlier stages, by the use of special staining methods.

While the outlines of this sex cell mass are vague at the outset, they become very clearly defined in later stages, when, first the myotome, and then the lateral plate tissues begin to use up their yolk material, while the sex-cells remain unchanged and do not divide. It then becomes evident that the sex-cell anlagen are continuous in the greater part of their extent, being somewhat interrupted only at their cranial and caudal ends.

At the stage with which this account begins, the Wolffian ducts have not yet been formed. So soon as they make their appearance, however, they lie immediately above and slightly medial to the sex cell anlagen. In still later stages, the latter are seen to shift toward the median line. This movement accompanies the growth of the lateral plates and appears to be caused by it. The sex-cell anlagen finally meet in the median line and the mesentery forms beneath them. They then migrate laterally to the anlagen of the sex-glands.

While it will be seen that this account is quite in agreement with Dustin's account of the origin of the sex-cells in *Triton*, and consequently at variance with the process described in my paper on the origin of the sex-cells in *Rana pipiens*, I have nothing whatever to retract from the observations and conclusions expressed in that paper. Repeated study of my old preparations and of many new ones have confirmed their accu-

racy Furthermore, the papers of King on *Bufo lentiginosus* and of Kuschakewitch on *Rana esculenta* have confirmed my work on *Rana pipiens* While Dustin strikes a discordant note in his account of the origin of the sex-cells of *Rana fusca* and *Bufo vulgaris*, it may not be wide of the mark to tentatively advance the view that the sex-cells arise in the Urodeles from that portion of the mesoderm between the anlage of the mesoblastic somites and lateral plate, while in the Anurans they arise from that part of the endoderm that forms the median portion of the roof of the archenteron. This is not inconsistent with the conception of the sex cells which is being more and more firmly established, namely, that they are cells preserved from early stages in an undifferentiated condition and that they are capable of considerable migration along radically different paths There must, as a matter of course, be a more or less close correspondence in these migration paths in closely allied forms, but radical differences might be expected in such fundamentally different groups as the Urodeles and the Anurans

Anatomical Illustration before Vesalius (with illustrations from original sources) W A LOCY, Northwestern University

On the Distribution in the United States and some Points in the Habits of Clinostomum marginatum HENRY LESLIE OSBORN, Hamline University

This trematode was first recorded in Europe by Rudolphi in 1809 under the name *Distomum marginatum* The following summary shows the records of its occurrence in this country with date, writer, name, host and infected part, and locality 1856, Leidy, *Clinostomum gracile, Esox*, intestine, Delaware River, 1877, Leidy, *Distomum galactosomum, Roccus lineatus*, Philadelphia, 1879, Wright, *Distomum gracile, Perca flavescens*, branchiostegal membranes, Toronto, 1879, Wright, *Distomum heterostomum, Botaurus minor*, mouth, Toronto; 1885, Looss, *Distomum reticulatum*, silurid fish encysted in muscle tissue, Porto Rico; 1895, MacCallum, *Distomum gracile*, frog, encysted in pectoral muscle, Toronto, 1897, MacCallum, *Distomum heterostomum, Ardea herodias*, mouth, Toronto; 1898, *Distomum gracile, Eupomotis pallidus*, pectoral fin and roof of mouth, Kansas City, Mo; 1901, Osborn, *Clinostomum marginatum, Micropterus dolomieu*, encysted in muscle, Nebish, Mich; 1901, Osborn, *Clinostomum marginatum, Ardea herodias*, throat, Nebish, Mich.; 1903, *Clinostomum marginatum, Rana virescens*, encysted in cœlom wall and subcutaneous lymph spaces, Saint Paul, Minn, 1903, Young, *Clinostomum marginatum, Micropterus dolomieu*, encysted in branchiostegal membranes and muscle, Troy, Ohio, 1904, Stafford, *Clinostomum gracile, Perca flavescens*, gills, Montreal Its distribution is thus shown to be very wide, as indicated by the names Philadelphia, Troy (Ohio), Kansas City, Saint Paul, Nebish, Toronto and Montreal And yet we do not know its primary host, the worm being virtually completely developed when found in the fish and frog It is a trematode of economic importance, since it infects the edible portion of one of our principal game fishes, though it is presumably not strictly harmful to man It is evidently very widely spread in northern and eastern United States and may be expected to be found outside the limits already noted as soon as search is made The habits of the worm were studied in the forms encysted in the bass The cyst is a perversion of the endomysial connective tissue and is wholly contributed by the host The worm in the cyst is bent twice on itself, the ventral surface being turned toward the inner surface of the cyst whose cavity is completely filled by the worm Immediately on escaping from the cyst the worm is very active indeed, its movements, besides many random and irregular ones, falling under two types a retraction of the anterior end, producing a club shaped front region possibly related with adhesion, and a thinning and flattening of the body such that its ventral surface becomes somewhat concave and the margins of the body assume the appearance of lateral fins. Neither of these two body forms were made practical use of by the worm, the body merely taking on the shape momentarily and then relaxing back at once into the resting form

The worms in the frog were studied at St. Paul They are not so much found in the muscle of the frog, their usual location in the fish, as in the cœlomic wall where the cysts lie, not in the muscular tissue, but between it and the peritoneum. The cysts, too, are very much larger than those in the fish and the worm is bent double within, the ventral surface being external. The cysts are similar in structure to those in the fish, being made up of fibrous tissue and supplied with a distinct capillary network

It is planned to publish this paper in the *Biological Bulletin*.

The Transmission of Trypanosoma lewisi by Rat Fleas (Ceratophyllus sp. and Pulex sp), with

Short Descriptions of Three New Herpetomonads. L. D. SWINGLE, Nebraska Wesleyan University.

The rat trypanosoma passes through a cycle of development in the digestive tract of rat fleas. After it is taken into the flea's stomach, it soon passes backwards into the intestine. The nucleus moves toward the posterior end, the blepharoplast toward the anterior end of the body and the undulating membrane is lost, so that a Crithidia results. Some of the individuals agglutinate by their flagellar ends and eventually form cysts. Others, by rounding off at the anterior ends, form cysts directly. In these the posterior end containing nucleus and blepharoplast remains very pointed. Forms resembling the "latent bodies" of *T. lewisi* were found in the crushed heads of fleas.

A case which might reasonably be interpreted as a conjugation of male and female forms was found.

The fleas harbor a natural flagellate, *Herpetomonas pattoni* n. sp. Two new herpetomonads are described: they are *Herpetomonas calliphoræ* n. sp. from *Calliphora coloradensis* and *Herpetomonas lineata* n. sp. from *Sarcophaga sarraceniæ*.

To be published in the *Journal of Infectious Diseases*.

The Nature and Origin of the Fish-fauna of the Guiana Plateau. C. H. EIGENMANN, University of Indiana.

Color Inheritance in Tumbler Pigeons. LEON J. COLE, University of Wisconsin.

From black tumbler pigeons crossed with red were produced in F_1 27 offspring, which were all black, with, however, reddish tips (often very conspicuous) on the feathers prior to the first molt. From these birds bred *inter se* segregation was obtained in F_2, which comprised 71 birds, of which 45 were black and 26 red. No explanation was offered for the departure from the Mendelian ratio. Furthermore, practically all these blacks in F_2 have reddish tips on the first feathers. This point was discussed in its relation to melanin oxidation and Mendelian inheritance.

Some results from other crosses were given.

Sex Ratio and other Reproduction Statistics in Tumbler Pigeons. LEON J. COLE, University of Wisconsin.

Statistics presented showed that of the two eggs laid by pigeons at a sitting each produces approximately an equal number of males and females, and that the chances are equal that the two eggs will produce birds of the same sex or birds of opposite sex. This corrects the popular notion that the two eggs of a sitting produce a pair of young (a male and a female) and that the first one laid usually, if not always, produces a male.

In 62 per cent. of 101 cases of tumblers the interval between the laying of the first egg and the second was 44 or 45 hours. Nevertheless, in a large percentage of cases the eggs hatch at approximately the same time.

The normal period of incubation is seventeen days, but birds allowed to sit on eggs which do not hatch will sometimes incubate up to thirty days.

(This paper and the preceding are based on experiments conducted at the Rhode Island Agricultural Experiment Station, the results of which will shortly be published in full by the station.)

A Note on the Metamorphosis of Lampsilis lævissimus. ROBERT E. COKER and THADDEUS SURBER, Fairport Biological Station.

The glochidium of *Lampsilis lævissimus* is of the "axe head" form similar to that of *L. alatus*, but without the hooks characteristic of the latter. The same form of glochidium is seen in *L. capax*, although in the shape of adult, *capax* is at an opposite extreme from *lævissimus*. Nevertheless, in certain significant taxonomic characters *lævissimus* and *capax* show agreement in the adult stage.

A few specimens of mussels in the stage of parasitism which show glochidial shells of the *lævissimus* form have been observed. These young mussels show a notable increase in size and a striking change of form as compared with the glochidial stage. It is not known that such marked changes occur in other species during the period of parasitism.

An Alpheus with Two Equal "Snapping" Chelæ. CHARLES ZELENY, University of Illinois.

Some Data concerning Dibothriocephalus latus in America, with Report of a Second Case of Infection Acquired in the United States. W. S. NICKERSON, University of Minnesota.

I have collected from physicians reports of the occurrence of the fish tape-worm (*Dibothriocephalus latus*) of man in 65 cases, 51 of which were in Minnesota. But six of these have been previously mentioned in literature. The hosts in two cases were Swedes, in one a Japanese, in two native born, and the others with few if any exceptions were Finns.

I have also to report a second case of *Dibo-*

thrococephalus infection acquired in this country. It occurred in a woman who was born and has always lived in Hennepin County, Minn., never having been out of the state except once for a visit to North Dakota. While there she ate dried and smoked fish (otherwise uncooked) and it was soon after her return home that she experienced symptoms attributable to the tape worm. The infection must therefore have occurred in America and from the eating of American fish.

Paragonimus in a Cat in Minneapolis: W. S. NICKERSON, University of Minnesota.

I wish to put on record the occurrence of *Paragonimus Kellicotti* in the lung of a cat from the grounds of the University of Minnesota. Three specimens were obtained.

An American Intermediate Host for Hymenolepis diminuta: W. S. NICKERSON, University of Minnesota.

The common tape-worm of the rat, *Hymenolepis diminuta*, is also an occasional human parasite, some fourteen cases having been reported. It has been shown in Europe that its cercocystis stage may be passed in several insects, the meal moth and its larva (*Asopia*), the earwig (*Anisolabis*), and beetles (*Akis* and *Scaurus*), *Asopia* being the form that commonly serves as intermediate host. In America an intermediate host has not been observed and attempts at experimental infection of our American meal worms have not been successful.

A case of infection of a child in Minnesota by *Hymenolepis diminuta* has come to my attention in which the circumstances suggested strongly that the diplopod *Julus* had been the intermediate host from which the child had become infected. Acting upon this hint I fed fragments of *Hymenolepis diminuta* to young diplopods, supposed at the time to be young julids. Some of these were found subsequently to be full of cercocystides agreeing fully with those figured by Grassi and Rovelli and which they demonstrated experimentally to be the young of *Hymenolepis diminuta*. Later I learned that my diplopods were *Fontaria virginia* Bollman of the family Polydermidæ.

In an attempt to repeat the experiment, using *Julus* instead of *Fontaria*, I was able to obtain but a single specimen of *Hymenolepis diminuta* with but few proglottides having ripe ova. In one of the specimens of *Julus* to which the proglottides were fed a few specimens of cercocystides were subsequently found which were of the same sort as those previously obtained from *Fontaria*.

The rearing of the adult worm (Hymenolepides) from the larvæ by feeding experiments was rendered impossible in both cases by the fact that the infected condition of the myriapods was not discovered until they were already dead. In view, however, of their complete agreement with the descriptions and figures given by Grassi and Rovelli of the larvæ of *Hymenolepis* and the way in which they were obtained there can be no doubt as to their identity.

These experiments show that at least two different genera belonging to the class Myriapoda may act as intermediate hosts for *Hymenolepis diminuta* in America. The intermediate hosts previously known in Europe are of the class Hexapoda.

Preliminary Account of the Early Development of Cirratulus grandis Verrill: JOHN W. SCOTT, Westport High School, Kansas City, Mo.

The common fringe worm of the Atlantic coast, at Woods Hole, is found in muddy ooze around the roots of eel grass. It is easily excited to oviposition, but few eggs will fertilize if deposited before 10 P.M. Eggs deposited during the night may be fertilized the next morning. The first polar body comes off in 10 minutes, and the second in 17 minutes. A yolk lobe is formed, may be constricted off, but is always reabsorbed. Unequal cleavage occurs at 49 minutes. The second cleavage, 8 minutes later, results in a three-celled stage. The entoderm appears to be separated at the first cleavage. The entoderm cell remains long undivided, and gastrulation takes place by overgrowth of other cells. The trochophore is scarcely able to leave the bottom and is never pelagic. At 51 hours it settles on the ventral side and moves like a flatworm, a ventral band of cilia is used for locomotion. Septa develop and disappear with the one exception found in the adult. An introvert arises as an infolding of the body wall posterior to the mouth, later a common opening serves for both. The introvert is used at this stage, chiefly for locomotion. The larva was kept until 20 days old.

An Accessory Chromosome in the Opossum: H. E. JORDAN, University of Virginia.

The number of chromosomes in equatorial plates of dividing spermatogonial and interstitial cells equals seventeen. Plasmosome present in resting primary spermatocyte. This stains intensely black in iron-hæmotoxylin, but only faintly green in Auerbach's stain (= methyl green + acid fuchsin). Plasmosome can not be traced into later

stages, but during synapsis a dark staining sharply contoured body (accessory chromosome) appears at point where the loops converge This point is always next the conspicuous centrosphere lying just outside of the nuclear wall Plasmosome believed to become accessory chromosome on basis of similarity of form, *i e*, bipartite character. In post synaptic stages, while the autosomes are still only slightly chromatic, the deeply chromatic monosome (accessory chromosome) always lies close to point where centrosphere is located

Equatorial plates of first maturation mitosis contain nine chromosomes (eight bivalent ordinary and one accessory chromosome) The accessory, both here and in earlier stages, appears bipartite, sometimes completely divided and separated The accessory passes undivided to one pole slightly in advance of the eight univalent ordinary chromosomes, the opposite pole receiving only eight chromosomes Two types of secondary spermatocytes are formed, one with a slightly chromatic nucleolus (= accessory), the other without Equatorial plates of second maturation mitoses show five chromosomes (four pairs of the eight univalents of last mitosis + one accessory) and four chromosomes, respectively In late telo phase the pairs are again resolved into nine and eight chromosomes, respectively Dimorphism of spermatids--metamorphosis into spermatozoa and the presence of chromidial elements—were also considered

This paper will be published in the *Journal of Morphology*

The Formation of the Spermatophore in Arenicola and a Theory of the Alternation of Generations suggested by the Facts in the Case. ELLIOT R DOWNING, Northern State Normal School, Marquette, Mich

The spermatophore in *Arenicola cristata* arises as a result of the cleavage of a primary spermatogonium in a manner homologous with the cleavage of an egg in the same species. There is an invagination of certain spermatogonial macromeres and micromeres to form the nutritive cells which supply the developing spermatophore with food by their disintegration and absorption These cells are homologues of the egg mesentomeres The spermatophore is shed from the testis into the body fluid at an early stage, sometimes even before the cleavage of the spermatogonium has begun Here the early spermatophore becomes a hollow mass of cells which later, by a false invagination, becomes gastrula-like. The false gastrula flattens out and becomes a saucer-shaped mass of spermatids. These develop within themselves the sperm.

The facts suggest that the spermatophore is an individual—the gametozoon which bears the gametes The adult male is a sporozoon which develops the spores or primary spermatogonia

The alternation of generations and reduction are independent phenomena, as is shown (1) by apogamy and apospory, (2) by the fact that among the protozoa and algæ reduction may occur before, during or after the conjugation of the gametes, that is, in either the sporo- or gameto-generation

Reduction is an adjunct rather than a corollary of sexuality If it were the latter, reduction should always occur in a definite relation to the sexual act, not before, during or after it

The spermatophore must be suggestive of the primitive animal type just as the gametophyte suggests a thalline ancestry for plants Perhaps the Volvocales come nearest, among living forms, the primitive form In *Volvox* reduction has its animal position during gametogenesis

If reduction occurred in the primitive forms before or during the fusion of the gametes the gameto- and sporo-generations would have the same number of chromosomes This is the case in the gametozoon and sporozoon of *Arenicola* Since all animals and many algæ have reduction in such a position the preponderance of evidence is that it had this position in the common animal and plant prototype In plants, then, it has shifted from this primitive place toward the end of the sporophyte generation

Aquatic Photography for Zoologists WM ALANSON BRYAN, Honolulu, H. I.

The paper briefly explains and illustrates with lantern slides some of the essentials in the method and the apparatus used in securing photographs of aquatic objects for book and class room illustration The successive steps in evolving a method that resulted in securing the first aquatic motion pictures are explained

The Discovery of Archigetes in America, with a Discussion of its Structures and Affinities: HENRY B. WARD, University of Illinois.

Among the monozoic cestodes, often grouped as a separate class or subclass under the name Cestodaria, the Caryophyllæidæ stand closest to the merozoic cestodes, particularly to the Bothriocephalidæ. Neither of the genera previously known, *Caryophyllæus* or *Archigetes*, has been reported from this continent, although several

species are relatively common in Europe. During the past summer, a form belonging to this group was found in fish from the Illinois River at Havana. Its structure shows certain features which are common to both of the known genera, *Caryophyllæus* and *Archigetes*. It resembles the former in the absence of a caudal appendage and in the location chosen by the adult parasite, viz., the intestine of a fish, whereas, so far as known in Europe, *Archigetes* always possesses a tail and has been found only in the body cavity of tubificid worms. In general appearance and structure the American form resembles the European *Archigetes* very strongly. It has a scolex of fixed form with primitive suckers or phyllidia and also the musculature of *Archigetes*. The general arrangement of reproductive organs, especially the two rows of testes in the central field, and the genital pores, correspond also closely to conditions in *Archigetes*. Two alternative hypotheses present themselves: (1) the European forms may have a yet undiscovered adult stage in some vertebrate host and in that case the caudal appendage would be lost as in *Caryophyllæus* and in the form under discussion, (2) the American form described here may represent a higher stage of development. In the latter case the European form is either a degenerate type in which the intestinal stage has fallen out of the life history, leaving only a sexually mature larva parasitic in the body cavity, as *Amphilina* another cestodarian has been interpreted by Pintner, or the American form indicates the adaptation by which the invertebrate parasite has acquired a vertebrate host and includes in its life history two hosts, as is typical in cestodes generally. The full paper will be published elsewhere.

Notes on Batinot Amphibia: ROY L. MOODIE, University of Kansas.

Chromosome Individuality: C. E. MCCLUNG, University of Kansas.

The Histogenesis of the "Transient" (Rohon-Beard) Cells in Selachian Embryos: H. V. NEAL, Knox College.

The study of the histogenesis of the "transient" (Rohon Beard) cells in selachian embryos confirms earlier conclusions based upon the study of the histogenesis of ventral nerves that the neuraxon process develops as an amœboid outflow of the neuroblast cell. The growth and histogenesis of the neuraxon process of the "transient" or "giant" cells of Rohon Beard may be easily followed, since in reaching its peripheral termination the process grows into and through spaces devoid both of mesenchyma cells and of intercellular bridges or "plasmodesmata." Such spaces, however, are filled with a plasma containing a slight amount of coagulable substance which with some fixing reagents gives the plasma a vacuolated structure. The termination of the nerve fiber or neuraxon, as it penetrates these spaces, consists of many pseudopodia like extensions. In some cases, as the neuraxon in its growth reaches the dorsal apex of the myotome, pseudopodial processes extend, some median and some lateral to the myotome. It seems to be a matter of chance whether in its further extension the neuraxon process shall grow median or whether it shall grow lateral to the myotome. Of a primary reticulum or "plasmodesma" connecting the neuroblast cell in the neural tube with its terminal organ there is not the slightest evidence. The experimental results of Harrison on amphibian embryos are fully corroborated by the evidence presented by the growth of the neuraxon processes of these "giant" cells.

Such facts obviously have an important bearing on the problem of the phylogeny of the vertebrate head, since they tend to disprove the assumption of earlier morphologists that nerve and muscle are inseparably connected and to make explicable the greatly modified metameric relations of the eye muscle nerves and possibly to give us the clue which may lead to the solution of the mystery of the chiasma of the trochlearis.

The Origin of the Rudiments of the Mesenteron in the Honey Bee: JAMES A. NELSON, Bureau of Entomology, Washington, D. C.

The anterior mesenteron rudiment of the honey bee arises at a period immediately after the appearance of the lateral folds, on the ventral surface of the egg near its anterior pole. It is at first nearly circular in outline, and sharply distinguished from the blastoderm by the deeper staining properties of its cells. At first it lies outside the area embraced by the lateral folds, but is later included in this area as the folds lengthen. Sections show that this mesenteron rudiment is produced by active proliferation of the cells of the blastoderm. After the union of the lateral folds this is detached from the blastoderm as a flat plate of cells which increases rapidly in extent, moves cephalad and soon covers the yolk at the anterior pole of the egg like a cap. The history of the posterior mesenteron rudiment is similar, but it is smaller, and first appears at the posterior pole of the egg. Later, after the rudiments of the appendages have ap-

peared, the stomodæal and proctodæal invaginations are formed at or near the places of formation of the mesenteron rudiments. The rudiments of the mesenteron at their inception are thus sharply marked off from the blastoderm of the middle plate (mesoderm) on the one hand, and the epithelium of the proctodæum and stomodæum (ectoderm) on the other These observations are in close accord with those of Carrière and Bürger on *Chalicodoma*

The so called blastopore and the yolk plug described by Dickel (1904) for the honey bee have been observed, but the writer can not confirm this investigator's conclusions relative to these structures The yolk plug, which Dickel thought connected with the formation of the mesenteron, was found in the same sagittal section with the true anterior mesenteron rudiment, the one on the dorsal, the other on the ventral surface of the egg, thus demonstrating that no close genetic relationship exists between them. The origin and fate of this so called yolk plug is obscure, but it is a transitory structure, of very brief duration, possibly a vestigial organ.

Birds of the Olympic Peninsula. ALBERT B REAGAN, U S. Indian Service

The Olympic Peninsula, Washington, extends from Grays Harbor on the Pacific coast north to the Strait of Juan de Fuca and east to the "sound" So far as the habitation of birds is concerned, the region divides itself into three parts—the coast strip, the mountains and the islands off the coast

The coastal strip ranges from twelve to thirty miles in width. The central, high section is a circular area forty miles in circumference in the east central part of the peninsula, ranging from 6,000 to 8,000 feet in height, with a declining ridge extending northwestward to Cape Flattery The whole mainland area, except in the high mountain districts, is heavily forested and covered with a dense underbrush so that near the coast it approaches the jungle state For this reason birds in this division are hard to find, as they can so easily seclude themselves, but at the beach line and in the island districts they are in evidence.

The land species generally met with are north western crow (*Corvus caurinus*), northern raven (*C corax principalis*), desert sparrow hawk (*Falco sparverius phalæna*), black cloud swift (*Cypseloides niger borealis*), American crossbill (*Loxia curvirostra minor*), Audubon warbler (*Dendroica auduboni*), rough-winged swallow (*Stelgidopteryx serripennis*), rufous hummer (*Selasphorus rufus*), rusty song sparrow (*Melospiza cinera morphna*), sooty song sparrow (*Passerella iliaca* (*fuliginosa*)), bald eagle (*Haliæetus leucocephalus*), black merlin (*Falco columbarius suckleyi*), Peale falcon (*Falco peregrinus pealei*), harlequin duck (*Histrionicus histrionicus*), ruddy turnstone (*Arenaria morinella*), Hudsonian curlew (*Numenius hudsonicus*), northern phalarope (*Phalaropus lobatus*), barn swallow (*Hirundo erythrogaster*), western winter wren (*Olbiorchilus hiemalis pacificus*), pectoral sandpiper (*Actodromas maculata*), western sandpiper (*Ereunetes occidentalis*), lutescent warbler (*Helminthophila celata lutescens*), russet backed thrush (*Hylocichla ustulata*), yellow warbler (*Dendroica æstiva*), black turnstone (*Arenaria melanocephala*), semi-palated plover (*Ægialitis semipalmata*), knot (*Tringa canutus*), wandering tatler (*Heteractitis incanus*), yellow legs (*Totanus flavipes*), also several species of ducks and geese (in migration)

It is the writer's opinion that there are 25,000 land birds in the peninsula

The islands are principally on the Pacific side and there parallel with the coast, extending from the mainland only a few miles seaward at most They number something like 100 points, rocks, pillars and islands proper. By position, they naturally divide themselves into three groups These groups were each made a bird reserve by President Theodore Roosevelt and designated as follows Copalis Rock Reserve, near Granville (Tahola), thirty miles north of Grays Harbor; the Quillayute Needles Reserve, in the vicinity of LaPush, Washington, and the Flattery Rock Reserve, including all the rocks and islands from the Ozette Indian village to the entrance of the Strait of Fuca.

These islands fairly swarm with birds The species most commonly observed are western gull (*Larus occidentalis*), glaucus winged gull (*L glaucescens*), Heerman gull (*L. Heermani*), marbled murrlet (*Brachyramphus marmoratus*),[1] California murre (*Uria troile californica*), black oyster catcher (*Hæmatopus bachmani*), loon (*Gavia imber*),[1] white winged scoter (*Oidemia deglandi*),[1] tufted puffin (*Lunda cirrhata*), pigeon guillemot (*Cepphus columba*), dark-bodied shearwater (*Puffinus griseus*),[1] surf scoter (*Oidemia perspicillata*),[1] Cassin auklet (*Ptychoramphus aleuticus*), rhinoceros auklet (*Cerorhinca monocerata*), American scoter (*Oidemia americana*),[1]

[1] Migratory.

Keading petrel (*Oceanodroma kaedingi*), Brandt cormorant (*Phalacrocorax penicillatus*), white-crested cormorant (*P dilophus cincinatus*), Baird cormorant (*P pelagicus resplendens*), western grebe (*Æchmophorus occidentalis*),[3] Holboell grebe (*Colymbus holboellii*) [3]

It has been estimated that the birds of the island groups, including the migratory birds, number at least 100,000

One hundred and thirty-seven species of birds have been listed from the Olympic Peninsula, and are described in the paper of which this is an abstract

The full paper will probably appear in the *Transactions of the Kansas Academy of Science.*

The Differentiation of Neuroblasts in Artificial Culture Media M L SHOREY, Milwaukee-Downer College.

The experiments to be described were conducted for the purpose of gaining evidence regarding the factors involved in the differentiation of neuroblasts Previous experimental work has led to the expression of two radically opposed views, one that they are entirely self-differentiating (Harrison, 1907, Braus, 1906), the other that no differentiation occurs except in the presence of the normal end-organs, or the products of the metabolism of these organs (Shorey, 1909).

Neuroblasts from the medullary canal of *Necturus* were placed in artificial culture media, one containing the products of muscular metabolism, and the other not In each the cells remained alive for a considerable period of time, but only in the first were fibers developed.

Spermatogenesis in the Mole Crickets. W. J. BAUMGARTNER, University of Kansas.

The paper will show the method of formation of the tetrads, and the method of maturation division The work indicates that while Vom Rath is correct in theory, his figures are not at all true to the conditions found in the specimens. His illustrations must have been drawn mostly from imagination

The chromosomes in the maturation divisions show a constancy of number, and a constancy of the series of shapes through which the individuals pass. The accessory is present, and one of the tetrads divides unequally

This paper will be printed in Kansas University Science Bulletin

H. V. NEAL,
Secretary

GALESBURG, ILL.

[3] Migratory

SOCIETIES AND ACADEMIES

THE TORREY BOTANICAL CLUB

THE first meeting of the club for 1911 was held at the American Museum of Natural History, on January 10, President Rusby in the chair. Dr. C A Darling, of the department of botany, Columbia University, was nominated for membership

This being the annual meeting, reports were presented by the various officers

The report of the treasurer was presented and upon motion referred to an auditing committee

The secretary reported that fifteen meetings had been held during the year with a total attendance of 467, as against 411 in 1909, and an average attendance of thirty-one, as against twenty-seven last year Twelve persons have been elected to membership, and eight resignations received and accepted Six illustrated lectures were delivered during the season at which the combined attendance was 319, as against 251 at seven meetings last year

The editor reported that the *Bulletin* for the year 1910 contains 630 pages and 36 plates, and that the expense of its publication was less than the amount allowed for it by the budget committee He also reported that only one paper had been published in the *Memoirs*, this being a paper by Dr. O Butler on "The Californian Vine Disease" The editor declined to be considered for reelection

The editor of *Torreya* presented a special report for that periodical The volume of *Torreya* for 1910 contained 292 pages

The chairman of the field committee reported that twenty-three meetings were advertised during the year, one of which was an afternoon lecture at the New York Botanical Garden Eight meetings were not held on account of stormy weather or from other causes At the fourteen field meetings actually held there was a total of 103 persons present, making an average attendance of a little more than 7 at each meeting.

As chairman of the local flora committee, Dr. N. L. Britton gave a brief report of the investigations being carried on by Mr. Norman Taylor on the local flora.

Election of officers for the year 1911 resulted as follows:

President—H H Rusby

Vice-presidents—Edward S. Burgess and John Hendley Barnhart.

Secretary and Treasurer—Bernard O Dodge

Editor—Philip Dowell.

Associate Editors—John Hendley Barnhart, Jean Broadhurst, Ernest Dunbar Clark, Alexander William Evans, Tracy Elliot Hazen, Marshall Avery Howe, Herbert Maule Richards and Norman Taylor

The following committees were appointed by the president for the year 1911

Finance Committee—John I Kane and H M Richards

Program Committee—Elizabeth G Britton, Fred J Seaver, Tracy E Hazen and Jean Broadhurst

Field Committee—E B Southwick, Norman Taylor and William Mansfield

Committee on Local Flora—N L Britton, chairman, Phanerogams N L Britton, C C Curtis, E P Bicknell, K K Mackenzie, E S Burgess and E L Morris Cryptogams Wm A Murrill, E G Britton, Tracy E Hazen, M A Howe and Philip Dowell

Budget Committee—H H Rusby, E S Burgess, J H Barnhart, B O Dodge, Philip Dowell and N L Britton

PERCY WILSON,
Secretary

THE ANTHROPOLOGICAL SOCIETY OF WASHINGTON

THE 450th regular meeting of the society was held in the hall of the Public Library, December 20, 1910, 8 P M., with the president, Dr J Walter Fewkes, in the chair

The paper of the evening was on "The Winnebago Winter Feast," by Mr. Paul Radin The speaker gave a description of the ceremonies incident to this feast and dwelt on the religious and social elements connected with the celebration

In the discussion, which followed the reading of the paper, Dr Swanton stated that among the Indians of the Pacific coast the ceremony is observed on the death of an uncle and to strengthen a chief, but in either case the social element predominates over the religious Mr La Flesche pointed out that among the old tribes the feasts are held about spring time, when life is awakened, heralded by the arrival of thunder Mr Hewitt and Dr Fewkes gave parallels from the Iroquois and the Hopi Indians, respectively.

THE 451st regular meeting of the society was held in the hall of the Public Library, January 17, 1911, with the president, Dr J Walter Fewkes, in the chair

The first paper of the evening was on "The Totemic Complex," by Dr A A. Goldenweiser. The speaker first gave a brief survey of the study of totemism from the sixteenth century to the present as represented by Frazer, Morgan, Lang, etc, in England, and by Boas and Swanton in America He then pointed out the difference of conception and method between the British and American investigators and subjected the English point of view to a thoroughgoing criticism This point of view is evolutionary and comparative It assumes totemism as a necessary stage in the evolution of religion and hence wherever it could trace the existence of one of the supposed elements of totemism, such as exogamy, tabu or totemic names, it established there the existence of the totemic system In this way totemism was attributed to the ancient Egyptians, the Romans, the Semites (by Robertson Smith) Dr Goldenweiser pointed out that the various features of totemism, such as exogamy, tabu and descent from an animal are nowhere found united, but exist separately and independently from one another and are hence not correlated to one another Totemism can, therefore, not be studied as an organic whole, but in its various elements The element of descent is the main feature which gives a social coherence and stability to a social group Next to this in importance is the bond of union formed by common ceremonies

The second paper was on "The Medicine Arrows of the Cheyenne," by Dr Truman Michelson The ceremony, which was attended by the speaker in 1908, consists of a long ritual, songs and prayers, and lasts through seven days. Of these the first three days are preliminary The persons taking part in the ceremony are the chief priest, the candidate or candidates who are to be initiated, each accompanied by a friend who acts the "old man" The participants live during the seven days in lodges or tents within a closed precinct The speaker recited parts of the songs and prayers addressed to sky and earth These are accompanied by processions, moving from lodge to lodge, burning of pieces of sweet grass, etc The center of the ceremony, which gives it its name, consists in laying arrows on the ground, with heads to north, surrounded by twelve buffalo heads The officiating priest goes through various motions, while the candidate breathes four times on the arrows. No woman may witness the ceremony.

Both papers were discussed by Messrs Swanton, Hewitt, Hough, Fewkes and Casanowicz

I. M. CASANOWICZ,
Secretary

SCIENCE

FRIDAY, FEBRUARY 24, 1911

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MSS. intended for publication and books, etc., intended for review should be sent to the Editor of SCIENCE, Garrison-on-Hudson, N. Y.

BACTERIOLOGY IN GENERAL EDUCATION[1]

IN casting about for a topic around which might be gathered a few thoughts suitable for this occasion, I was impressed with the lack of appreciation of the value of bacteriology in general education and the comparatively small amount of systematic effort that has been put forth to establish efficient methods for teaching this important new science. I became so deeply interested in these phases of the subject that perhaps with more zeal than wisdom I chose for my topic "Bacteriology in General Education."

The practical value of any branch of science keeps pace with the general knowledge of it and an understanding of the methods by which it can be applied. This in turn depends largely upon the teaching of those who are versed in its details of fact and law. The earlier recognition of bacteria did not suggest the important rôle they play in nature's economy. While their existence had been known for more than two centuries, it was not until their causal relation to infectious diseases was recorded that they made an impression upon society in general, and the medical profession in particular. It was the discovery of this great power which they possess to destroy man and beast that afforded a point of contact between humanity and this vast, invisible, organic world about us. If I correctly understand the meaning of our declaration in the constitution of this society, that its object is the promotion of the science of bacteriology, it would seem

[1] Presidential address delivered before the Society of American Bacteriologists, Ithaca, N. Y., December 28, 1910.

that our first and most sacred duty is to ascertain the facts in the life history of microorganisms, to describe the laws governing them and to bring this knowledge into bold relief, in order that so far as possible it may be utilized for the benefit of humanity.

It is often the tendency of men who spend their lives in the seclusion of scientific research to become less mindful of the possible practical application of their work than they are of the technical details and of the truth which it reveals. This is of necessity a natural tendency, for application can not go in advance of the discovery of the facts to be applied. History is replete with illustrations of unsuccessful efforts to benefit humanity by applying theory or dogma in the place of knowledge which perhaps at the time did not exist. On the other hand, the results of investigations of the men of pure science have often led to the formulation of exceedingly practical procedures. In the development of the theory and of the application of a science, therefore, we have to deal with two factors, namely, the intellectual longing for truth regardless of its immediate significance, and the desire to apply specific knowledge for the benefit of society. Occasionally these two elements are equally marked in the same individual. As an example of a mind dominated by the experimental method, as well as the desire to alleviate the suffering and to improve the life conditions of mankind, there is no name that can be mentioned with greater fitness than that of Louis Pasteur, the founder of bacteriology as a practical science.

Almost from its inception, bacteriology has been a technical subject with important practical applications. It has been the agent that has revolutionized the medical professions, vegetable pathology, dairying and soil economics. The bacteriological work that is being done at the present time is for the most part aimed directly at some one or other of the problems in these practical fields. There are few sciences in which the newly discovered facts or laws have been so quickly utilized for some real or hoped-for benefit to man or beast, as in microbiology. The result of this haste to apply new theories has tended to confuse the public relative to the possibilities of a knowledge of microorganisms. It is difficult to have the truth crystallized that bacteriology is a technical subject which can be understood by the specialist only. The tendency to immediately apply newly cited facts, before they are properly demonstrated, has not infrequently permitted errors to be proclaimed as truth, with ultimate disappointment for both those looking for beneficial results and those attempting to attain them by the use of methods based on somewhat hypothetical data.

This is illustrated by the present confusion relative to the various groups of bacteria. The discovery of the tubercle bacillus was followed by the declaration that it was the same in all mammalian tuberculosis. This assumption was applied in the prophylactics of tuberculosis before the important fact was ascertained that there are varieties or races of tubercle bacilli, and also that there exists a large group of bacteria morphologically and micro-chemically at least related to them. Laymen and even medical men are having difficulty to reconcile more recent findings with the original teaching relative to the identity of mammalian tubercle bacteria. I do not refer to this disparagingly, for progress is sometimes made by retreats as well as by advances, but could the truth concerning the tubercle group of bacteria have been determined before the application of the hypothesis that the etiological

factors of human and bovine tuberculosis were identical, much controversy would have been avoided and numerous sacrifices and hardships would have been saved. I have called attention to but one of the important subjects in which the earlier positive statements have been greatly modified by later discoveries, for the purpose of emphasizing both the difficulties and the responsibilities of the bacteriologist in developing a pure science and in applying it in a practical manner.

From the earliest times, life has been given the highest price in the rôle of earthly possessions. How to prolong life has been the theme of many. In more recent years, economists have considered at length the cost to the state resulting from immature death and for maintenance of its sick and diseased citizens. The country is spending millions of dollars annually to support hospitals and asylums for the incurables. As Messenger has stated it, such a work is greatly to the credit of our hearts but not so much to the credit of our heads. Society has been temporizing with these great vital and economic questions, for the aim of the future is to restrict the need for hospitals by preventing disease. The nation-wide conservation movement has a large task to prevent the damages wrought in nature's economy by microorganisms. Again the state and society are calling upon the bacteriologists to bring to the pressing needs of to-day a knowledge of the vital forces that will tend to purify polluted streams and make the soil more fertile. The prevention of infectious diseases and the conservation of the soil are two great tasks that confront practical bacteriologists. The question is: How, in the present demand for applied bacteriology, can this science attain to its highest development and at the same time render the greatest service? The declaration in our constitution limits our field to the promotion of the science of bacteriology, while other organizations have largely for their duty its utilization. It is practically impossible to make this differentiation complete, for as yet there are no societies that seem to deal with the application of important recent bacteriological findings. It is clear, however, that the essential purpose of this organization is to safeguard the purity of the science and to point out the way for its advancement.

The fact has already been conceded that bacteriology is the science that has much to do, and in certain instances practically all to do, in finding the solution and in settling the details of many of the common every-day problems in the conservation of life and health of the higher forms of life. Yet this science, with such possibilities, possesses scarcely any interpreters of its actual value to society at large, and it finds little or no place in the curriculums of our schools and colleges for general education.

The true significance of a knowledge of bacteriology should require no explanation. Because it has grown up through technical laboratory research and routine, educators seem to feel that its true service is restricted to such laboratories. For the highly specialized or professional work we agree, but should not the knowledge of basic facts and natural laws that have transformed so many practises in medicine, sanitary science and agriculture become common property? Is there not a place in our common schools and liberal arts colleges for courses in bacteriology for the purpose of imparting fundamental knowledge that will enable society to come into possession of an understanding of this science? It can not be successfully gainsaid that information concerning the cause of fermentations, the storing of nitrogen in the soil, the causes for the changes in food stuffs

and the etiology of the common infectious diseases is as important, or the acquisition of such knowledge of as much disciplinary value, as the study of the life history of the denizens of the deep as now required in many if not most biological courses The world looked with wonderment at the hitherto unparalleled success in avoiding preventable diseases by the Japanese army at the time of the Russo-Japanese war Up to this conflict it is affirmed that for every man killed with a bullet in war four died from infection, while in the Japanese army for every man who died from infection four were killed with bullets The explanation of this victory over all the experience of the past was found to be the training of the Japanese soldiers in the principles of bacteriology It should be clearly understood that this marvelous success was due simply to the application of knowledge which Europe and America had brought forth and which the Japanese had applied Would it not be quite as valuable in civil life to have the people versed in the simple facts and principles of a science that would enable them intelligently and designedly to avoid infection, strengthen the efforts of the sanitarian, and enable the agriculturist to restore fertility to the soil, as to have them possessed of a knowledge of things far remote from their immediate environment? It is not my desire to belittle any course of instruction, for all knowledge is valuable, but I do wish to record the opinion that a science like bacteriology, which plays such an important part in the immediate physical well-being of every individual, should have a place in the curriculum of the schools for the masses

Because bacteriology is a technical subject with numerous avenues of usefulness there is the greater need, in order to prevent errors in its adaptation, for efficient instruction concerning it in both popular and technical schools The prevention of its false application will attain its maximum success after the diffusion of knowledge concerning microorganisms Knowledge is power, and when the people are versed in the fundamental principles of this science they will avail themselves of such information to improve their condition economically and to avoid the dangers of infection

The position occupied by bacteriology in general education will depend largely upon its teachers At the present time it has not been granted, with few exceptions, a place in the curriculums of popular educational institutions Sanitarians and others have endeavored to educate the people in its principles by imparting isolated facts This is having a certain beneficial effect, but unfortunately the recipients are unable to adapt this fragmentary knowledge to new conditions At present the masses depend for their guidance in this subject upon the results obtained in professional laboratories and the teaching in technical schools As bacteriology had its origin in the findings of those seeking the cause of important phenomena, it is to be expected that, for a time at least, its fountain head will continue to be in the results forthcoming from such researches As these investigators are largely its teachers, we are brought to a discussion of methods for teaching it in professional schools

I am led to touch upon this subject from the point of view of students, as I have known them, who have received their elementary training in bacteriology in different places Every one who has to deal with post-graduates in this subject appreciates fully the difficulties encountered in properly orienting the subject-matter taught to beginners in order to produce the desired

result. It is the presence of these difficulties that prompted the opening of this subject, which can not be closed until after the results of many trials and careful discussions are recorded. On my shelf are numerous text-books and laboratory manuals for teaching this science. If they are carefully analyzed, they will give a variety of impressions as to the purpose of the course prescribed. Here then is found the logical reason for the discussion of the fundamental principle in its teaching. The crux of the question is: Shall bacteriology be taught as a science in our professional schools or shall simply the essential facts to be applied be imparted?

Some years ago I accepted a position carrying with it the responsibility of teaching bacteriology in a professional course. I went from a research laboratory where I had grown up with the technique and knowledge of a certain phase of the subject. I labored under the delusion that the essential elements could be easily taught. There was no difficulty in securing the interest of the students, but the pangs of disappointment were mine when these same interested men attempted to apply the knowledge I supposed they possessed, in the actual practise of their profession. Their errors were not more grievous than those of other men, but the things they did and the kind of assistance they sought pointed clearly to a lack of knowledge or understanding of the subject which I believed I had taught with great clearness. This combined experience has caused me to question the efficiency of many pedagogical methods employed in teaching bacteriology, and to test as best I could different methods of instruction. The conclusion that seems to me inevitable is that the course in bacteriology must be dominated by a scientific system of presentation and that the technique, facts and laws of bacteriology must be clearly developed before too much stress can be placed upon the value of fragmentary facts such as staining tubercle bacilli, or the examination of water for the colon bacillus. The difficulty does not rest alone in a lack of the knowledge of technique in making the examinations, but quite as much in the inability to interpret the findings. Conclusions drawn from isolated facts by partially informed individuals are responsible for many of the charges of error against our laboratories. There is, therefore, no way to more effectively promote this science than to have its conclusions based on accurate and verified data.

I have considered the difficulties encountered by way of lack of time granted to bacteriology in curriculums, the eagerness of many inexperienced men to assume charge of bacteriological work and the pittance of salaries often paid for this service. These are recognized hindrances, but they are far more easily overcome than the results of hurried application, snap diagnosis, indifference and commercialism that dominate this work wherever the spirit of science and regard for scientific verification are not enthroned. If the public is to be benefited, as it should be, by the existence of this science, it is important that those responsible for the training of men to occupy positions in public laboratories take fully into account the nature of their teaching. Wherever the true scientific spirit dominates the final results prove to be more helpful. It is not my purpose, nor do I believe it possible, to outline a schedule to be followed by all. It is, however, within our power to give to bacteriology the dignity commensurate with its vital relations to our environment and to teach it as a science and not as an aggregation of biological facts.

I can not leave this subject without

pointing to the possibility of misguided application of this science because of a lack of understanding of it The mere knowledge of the presence of microorganisms in milk, in water and in dust is responsible for many unprofitable propaganda In following these, the real dangers may be overlooked This is illustrated in certain practises There are, for example, those who, because of a low bacterial count of milk, consider it of excellent quality, without taking into account the condition of the udders or the general health of the cows from which it was obtained In certain lines of domestic science much stress is placed on the bacterial content of dust and the unsanitary condition their presence creates, when the actual problem is simply one of cleanliness, as the organisms present are of less significance than the dust itself Regulations based on certain microbian findings and the importance thereof are frequently appealed from because of the seemingly unwarranted expenditures they impose. Many of these interpretations prove later to be without justification, and the annoyance and perhaps hardships they occasioned would have been avoided if the science of bacteriology rather than a few isolated facts had been applied

There is at present a great demand for men who are capable and qualified to bring to the aid of those struggling with great sanitary and economic problems the relief that is possible, or that seems to be attainable by the utilization of the laws of microbiology The question we have to consider is how this demand can be satisfactorily met How under the present restrictions of bacteriology in technical schools and the willingness—because of the lack of knowledge of it—to keep it out of curriculums of schools of liberal arts and sciences, are we going to secure the men and train them to efficiently occupy these positions? The answer may come that our problem does not differ from that existing in other biological and physical sciences This may be true, but the fact remains that we are a body organized to promote this science and consequently clothed with responsibility that we can not throw off relative to the ways and means to be employed in bringing into existence more efficient bacteriology The lesson taught by the older branches of knowledge, such as chemistry and physics, points to but one solution, namely, the upbuilding of the purity of the science

Thus far, bacteriology has operated as an aid to many branches of applied learning, like medicine and agriculture, and for that reason it has not reached its full development as an independent science Because of this its greatest value has not been secured by those activities which it has served Its application has been so immediate that most of those who have come in possession of any knowledge of it have been attracted to some field for its application Some of these places require more breadth of knowledge than others, but there are indeed few of them where bacteriology is dignified as a pure science and its truths and laws studied, tested and cherished as such. The difficulties met in nomenclature, bacterial floras and technique speak for themselves concerning the fragmentary status of the knowledge of this subject With its diversion to practical lines there is too much specialization before there is a foundation of basic knowledge sufficient to support the superstructure. The desire for application rather than the scientific spirit is manifested too early and often too conspicuously in the devotees of this subject.

Perhaps the greatest difficulty in finding men desirous of taking up bacteriology for a life work is the fact that it is an un-

known topic to them until they reach it in some technical or professional course By this time their mind is usually centered on the line of attainment desired, and the hurried instruction they receive in bacteriology does not illuminate the science sufficiently to attract them To overcome this, two alternatives present themselves, namely, to have a preliminary course in bacteriology in the preparatory school or to have the course in the professional schools extended and taught more efficiently It seems to me that it is a mistake to assume that persons who have received instruction in some narrow field of the subject, and who may decide to follow this work, are qualified to take at once positions of responsibility There is no other science where accuracy, correct interpretation and application are of more vital importance than they are in this, yet there is no other science where men are elevated to positions of responsibility with so little real preparation We seem to have forgotten that in the acquisition of knowledge and the coming into an understanding of bacteriology the element of time and the discipline of routine work and research are as essential as they are in chemistry or in physics Again, in the preparation we must not be unmindful of the necessity of a thorough preliminary training in the fundamental sciences and modern languages

The question is a perplexing one The errors of insufficiently trained workers call forth trying criticisms that those who are responsible for laboratory work must bear Yet when more thoroughly qualified men are sought for they can not be found What then are we to do? We each and all who are in professional schools must feel that the regular course or courses we give in bacteriology can not fully or adequately prepare one for teaching the subject or taking a responsible position in it Yet the student has ability, is earnest and a hard worker He is financially so situated at the time of his graduation that he can not continue his studies In this condition the acceptance of the proffered position, with the mental resolution that he will study hard and later do graduate work, is apparently the thing for him to do The outcome of such a course is well known The numerous and unexpected difficulties attending the new position together with the increased amount of routine exhaust the energies and the hoped-for special training is rarely secured and the desired efficiency is not attained Until we have a better system for preparing young men the present practise will continue and our science, our laboratories and the public must suffer the consequences

I have dwelt somewhat at length on the difficulties which exist in the promotion of the science of bacteriology If they are analyzed it will be found that they are temporary, and incident to the way by which man found his dependence upon his microbian environment After the numerous demands for men to do work, which the recognition of the importance of microbes has created, bacteriology will undoubtedly develop into a pure science that will be as eagerly pursued as any branch of learning in the acquisition of an efficient education.

In conclusion, I desire to make a few suggestions as to the possible means for both promoting this science as such and increasing its value as an asset in practical knowledge.

The first is to introduce in the courses of biology in our common schools, instruction on the existence and varieties of bacteria, and something of the action of a few of the more important economic species This would afford a little fundamental knowledge to help the masses to better understand the cause of many natural phenomena.

The second is that there should be established in our normal schools, colleges and universities thoroughly scientific courses in bacteriology. Such a course would lay the foundation of the science and place it on a par with other branches of biology, such as botany and zoology. Such departments should be prepared to do research, thereby fitting men for the special phases of the subject in technical and professional schools, and qualifying others to do research of a purely scientific nature, without reference to any particular trade, occupation or profession. The problems here are as numerous and their solutions are as taxing upon the mental forces of the investigator as they are in any branch of scientific endeavor.

The third suggestion is a plea for more scientific methods of teaching bacteriology in our professional schools. The course should, as a rule, be lengthened and the theoretical teaching supplemented by as much practical work as possible.

We should in view of all conditions rejoice in the achievements of the first half century of practical bacteriology. There is every reason to believe that with a better understanding of the vital relation of the microbian environment to higher forms of life bacteriology will be productive of still greater benefits, because of the education of the public concerning it and because of its more intelligent application by all.

VERANUS A. MOORE
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THE PALEONTOLOGICAL SOCIETY[1]
ADDRESS OF THE PRESIDENT

THERE is a respectable virtue in the observance of well-tried usages. In the societies out of which we have emerged it has been the established procedure to penalize a retiring president with a somewhat formal address. It is a practise which is at once a solace and an opportunity, the former, inasmuch as successors to this honor of office must share these heart-searching efforts of its closing hours, an opportunity, for here is an outlet to unspoken cogitations which seldom take on the formal expression of the printed page, a chance to weave together the threads of evidence or suggestion we may have followed many years and left dangling, perhaps even, to perfect into some well-finished form the summation of our larger problems. It seems to have been tacitly assumed by our council and membership that I should inaugurate for this society the accustomed procedure anew. I frankly face this situation, but with no promise of the adequacy of the outcome.

I. At the outset I propose to take brief advantage of my own somewhat peculiar position and experience as a public official in paleontological science as a point of view from which but few of you, my audience, may have had opportunity to contemplate the subject. You will, I pray, be indulgent with this exploitation of a personal attitude, for it does seem to have certain complementary attributes which may in a way illuminate and supplement your own experience. If you find it a rather frank expression it will be couched in terms of fraternal regard, and I hope entirely devoid of unfair or invidious comment which might expose the writer to the charge of being a profane railer at the sanctities. My contact with the public of an intelligent and progressive government is now of rather long standing and this experience has been illuminating in any estimate of public sympathy with pure science.

[1] Delivered by request at a joint meeting of this society and the Geological Society of America, Pittsburgh meeting, 1910.

It is safe to say that most of you are doing your work in the atmosphere of academic vales and cloisters where the prosecution of pure science is an elemental virtue. The very air you breathe is an inspiration to pursue any esoteric cult to any limit, howsoever far it may shape its course away from any apparent direct bearing on human happiness. An enlargement of human knowledge, even though already enlarged beyond human power to grasp, and the possibility of enlarging the comfort and hopes of mankind are justification for this pursuit, if justification be called for. Happily it is not needed, for the very next step, the scientific fact that lies unturned at our feet or the discovery just round the corner, may be as essential to philosophy and to progress as all that have passed by in their countless array. At your command is all that is best in the sciences and among your academic fellows in towns well oxygenated by the very air you exhale, you attain to the full measure of useful citizens. It might be trite for me to say that glorified with a splendid growth in the conservatory atmosphere of the university, the professor of science strays abroad from penetralia of his divinities with an acquired confidence of superiority, into a hardier air and a coarser grained world which declines to take him at his own valuation. I am disposed to think the sheltered aisles of great federal bureaus afford a very like protection from the assaults of the so-called practical community.

But take a man of pure science, and stand him out in the open where he must come into daily contact with men of affairs, men who are making a noise and doing that part of the world's work which feeds upon publicity, with the pulverizing wheels of political machinery and with the commercial sentiment which dominates to-day more than ever before nearly every phase of government and nearly every aspect of society, and if he fails to take his own measure of so-called "practical" usefulness to his community of city or state, it is taken for him. If he can stand the shadowless glare of such an attitude he realizes at length that he is not indeed as other people are. By devotion to the duty his science imposes he may merit the confidence of his sponsors, but he is not likely to become the director of a bank or be invited to sit as a member of important fiduciary or social trusts. He is, in plain truth, quite generally regarded in the community as a rather unproductive if not visionary member of society with a large supply of useless knowledge but with a very limited capacity for making dollars, not always immaculate in his attire or particularly well groomed in person, somewhat terrifying socially, though harmless, perhaps, in his honest effort to turn a rather unintelligible hobby into the means of a livelihood. This expression is not, I think, an unfair phrasing of the general public attitude in our communities toward, not the man of pure science alone, but all high scholastic attainment. Notwithstanding the intellectual regeneration beginning with the last half of the last century which has tended to place all lines of human thought on a scientific basis, our best communities are still largely thinking deductively, and the rest entirely so whenever their thoughts have time to reach beyond their income; and we too may indeed confess freely and without shame even in this presence that something more of the prophet's vision, of the philosopher's method and of the poet's inspiration is stealing back into our own intellectual modes. You and I, men who are giving our best years and skilled energies to the elucidation of the organic law, the higher

law which alike makes the flower bloom and the philosopher think, the one law which governs all the world save only human society, are reasonably content in our security that we have chosen the good part and we decline to subject our standards to those of the eminently companionable and high-minded citizenry of the communities in which it has pleased God to place us

Paleontology is, in my oft-asserted conviction, the most far-reaching of all the sciences In it lies the root of all truth, out of it must come the solution of the complex enigmas of human society Whatever it may be in the first instance, it is in the event that greatest study of mankind—man It is the panoramic display of the life of the ages, the expression of the organic law of a hundred successive worlds To quote the expression of Depéret it has won its independence and is now marching hand in hand with biology toward the discovery of the history of the development of living beings and the laws which control their transformations We unbar its doors and unlock its secrets only with the key of the present. To me it seems idle to fatuity to magnify the supposed imperfections in the record of life on the earths that have passed Such efforts are constantly recurring, and when taken out of their proper setting are the last resort of the theorist and the special pleader. The known fauna and flora of the living earth is a percentage of the actual fauna and flora, and only in less degree is the known life of the past since Azoic time to the actual life of that past The argument here has never been adequately presented, the facts never fairly marshalled, and we all too easily in our self confidence are wont to forget that after only a few brief years of study of the earth we still are standing at the threshold of the earth's history and with a few facts in our possession grow impatient to habilitate the earth, while its deeper chambers still conceal records reserved for our successors to uncover. In the long ages which lie before the human race must come through greater wealth of knowledge a clearer view and more fruitful application of the truth we seek To-day we begin to see the broad generalizations of the biologic law as based on paleontology which twenty years ago we believed so secure and illuminating, slowly yielding under the weight of accumulating evidence, and we should realize more deeply than ever and should, I believe, endeavor to leave the impress on our successors that it is still more knowledge that we require—it is still the facts we want, rather than the apparent inferences from those we have Were demonstration of the propriety of this attitude required, let me venture to cite, as an interested onlooker, the enormous volume of unpublished data bearing on the life of Cambrian time which has been brought together by the secretary of the Smithsonian, facts which when known and assimilated must modify nearly every published conception of the development of life on the early earth A few years ago at the opening of this century I ventured to address a personal letter to some ten men recognized as European leaders in geological work and thought, asking an expression as to what, in their judgment, would be the problems before the geologists of the coming generation The replies were all alike in essence and reducible to this: The acquisition of more facts. To-day we see only through a glass darkly into our cathedral where the truth lies enshrined

We know well enough, indeed it is a healthy sign that we are growing painfully conscious, that the standards of our best civilization are not those which have been

derived from a clear apprehension of the paramount law. We are certainly justified in our impatience with these standards so far as such impatience helps to make them or mankind better Whoever seriously contemplates the historical development of our culture standards out of a barbaric past can hardly fail of restiveness under them, whether of our educational system with its burden of time-worn incongruities and maladaptation to highly differentiated individualities, in which to the common scandal of the race our youth have been treated as papers of pins, machine-made watches, or as communities of ants, of our various religions "with their mossy heritage of half truth and half fiction," of commerce with its Midas dreams and cut-throat ethics But it is not likely that we can effect any perceptible influence upon these only as the pebbles of truth, brought together by the patient and persistent search which we pursue and encourage, cemented by the pervasive law of life, will some time make more secure the foundation for the superstructure of society Men of science are freely accused to-day of a *snobisme scientifique* The reproach comes pretty hard and fast from certain highly deductive quarters peopled largely by conventional thinkers And it is not always in French, either We may make all allowances for criticisms of our work based on a point of view quite inconceivable to consecutive inductive reasoning, but the fact is quite evident that scientific snobs and scientific snobbishness do abound A clergyman of my acquaintance asked a scientific friend about his work—what vast problems were now occupying his mind, and with utter and quite needless frankness the answer was—Repairing the conclusions I arrived at last year That quickly served to point a sermon on the errancy and frailty of inductive science. But while the clergyman and the type of thought he stands for ought to know that progress in knowledge is never along direct lines, always in bewildering zigzags and pulsations which nevertheless end further forward than where they started, still the man of science does himself and his work an injustice in permitting himself to be exploited by agencies of popularization which are in essence entirely hostile to his mode of thought So long as the whole pathway of science is bordered by the graves of cast-off theories and the atmosphere of to-day reeks with the aroma of new theories standing on probation and some in dire need ot burial, it is wholesome to stop and reflect that these in their turn are likely to be inhumed with only rotting stones to mark the names of their progenitors

We must recognize the fact that there is to-day a palpable reaction against the scientific mode for which we are ourselves to blame The uplifting impulse given to every department of thought by the revival of the last decades of the nineteenth century is followed in this decade by a tremendous rebound We may not all be fully conscious of this, as we are in some measure aloof from the pulse of other than scientific thought, but its proportions are well expressed by the formal and direct organization against the scientific mode embodied in such a masterly structure and so well-generaled an army as the eucharistic congress Let us not deceive ourselves, this great body of serious-minded deductive thinkers marshaled for no other purpose than to counteract the logical and the obvious and to encourage reliance on the mysterious is not standing alone. The ease with which we make and unmake hypotheses, the finality with which we enunciate propositions, the autocratic statement of possibilities as facts unques-

tionably tend to lead pure science into disfavor wherever the humanities are more prevalent. This unhappily growing disposition to finality of statement, forgetting that we are still watching only the first scene of our drama, is, I think, essentially at fault, and we are ourselves largely to blame for an evidently increasing indifference with which the autocratic theories of science are now received. Nothing fails in our philosophy, there is neither want of majesty or fullness of truth in our objective. But men of science need to mend their manners.

The vast majority of all our communities to-day are almost wholly abandoned to commercial pursuits. However this truth may be paraphrased, the euphemism of "making a living" applies to the absorbing share of human activities, instigates the volume of our legislation, controls our international relations, impregnates conceptions of the conservation of natural resources and lies at the base of all the comforts and conveniences of life which we now enjoy in unparalleled measure. Commerce has been the advance agent of civilization, has reduced the wilderness to an Hesperidean garden, is the seat and source of power of one over another, whether of individual, state or nation. To the advance of commerce both science and art are under tribute, but to the commercial spirit itself the human world owes no good thing, no higher thinking, no advance of vital truth, certainly no ethical progress. It is, like the lust of blood, a primitive impulse which still overpowers the race and it gives the reflecting man some notion of how short is the way he has traveled toward excellence and how long the road that lies ahead. "Science," says a recent writer, "means service." That is applied science in its relation to the state, and it is well. But "science" has a profounder philosophy and blessed it is for humanity that the scientific *ideal* is sometimes wholly supreme and the *achievement* wholly incidental.

Experience and observation have deeply impressed me with the conviction that the most subtle intellect in our communities is that of the lawyer. I use the term only in its broadest and best sense. Trained to precise and consecutive thinking, averse to conclusions without full substantiation in fact or precedent, dealing with, at the bar, but perhaps, abhorring from the bench, hypotheses and reasonable presumptions, skilled in holding judgment in reserve and averse to dogmatic statement, the very intellectual practises which have effected these traits have helped to evolve a mental machine of extraordinarily delicate caliber and accurate register.

I can conceive of no finer training for a scholar of pure science than a course in the precedents and procedure of the law, if not carried too far, or if not that at least such intimate personal association with members of the legal profession as will help to irrigate the method of the scientific man with the mental prudence and reserve of the lawyer. Such a training would be better than Greek. The body of men that constitute the tribunals and the advocates in any country are the most influential element in conserving its culture. They are an anchor to windward. For human society they perform a function comparable only to that of the conservative mother in humanity; they ensure the perpetuation of the type.

But the lawyer is a dead wall to the progress of scientific truth. Deference to the common law, allegiance to the statute law, seem to have developed in him, both by training and association of ideas into the essentials of an instinct. We will not assume that the shortcomings of the con-

venances of the statutes are not more evident to him than to any other intellectual class in the community, or that he is blind to the mere expediencies of most legislation. Decent regard for the historic corpus of the law which embodies the experiences of self-governing people is essential to our community existence, but among the lawyers I have known best there seems to be ever a really inadequate apprehension of the essence of the law as expressed in Froude's definition of the term. "Our human laws," says Froude, "are but the copies, more or less imperfect, of the eternal laws so far as we can read them, and either succeed or promote our welfare, or tend to bring confusion and disaster, according as the legislator's insight has detected the true principle or has been distorted by ignorance or selfishness."

In fact, the natural law finds as yet feeble expression in our statutes. Certainly its recognized bearings are becoming incorporated into the laws of this land only as these recognized factors protect or guarantee the material rights of the people. But it is clear that neither the bare fact of legislation nor the decisions of the courts rest on any adequate conception of the workings of the natural law. Deference therefore to the written statute on the part of those whose intellectual energy is devoted to its interpretation or its execution, seems to have well-nigh suffocated the purpose to grasp the higher law on which governments built to endure must be established. Pure science which concerns itself in the search for the actual law regardless of its bearings on the present constitution of society, finds amongst this class in the community toleration, indeed, but little sympathy.

Of the three so-called learned professions in our early communities, the "doctors" constituted one. They do yet. To them we owe a debt which can not be expressed. Their contributions to a knowledge of the biologic law are immense, far greater indeed than many of that profession realize. Speaking generally and broadly, it is fair to say that the physicians and surgeons of our community have worked out to approaching completeness the anatomy and functions of the most intricate and highly specialized member of the animal creation. It is probably true that, with brilliant exceptions, they have not often looked long or seriously into organic nature beyond or below man, nor sought the solution of his complicated morphology in its earlier expressions or in its history. No doctor of medicine or of human anatomy would have conceived a theory of natural selection or any other procedure of organic evolution. It was bound to come either from the student of pure biology or paleontology or from the poet. Starting at the top instead of the bottom of the ladder of life, by empirical methods fraught with immense consequence to humanity, they have solved many of the mysteries of life.

Concretely viewed, the appealing merit of their part in the revelation of the natural law lies in its contribution to human happiness by the relief of human misery but abstractly this application is of no concern in the philosophy of nature. The physical man is an item in the scheme of life and he would be audacious indeed who would say he was more. But it is the most compelling fact of existence that we are that item and it is our comfort and progress that has been and are to be largely ensured by these conservators of our being. We may smile with some degree of indulgence over this monopolistic trade-mark of doctor. You who have earned your doctorates in science or laws by long years of close application to arduous work will find

your achievement unrecognized by the doctor of medicine who acquired his degree by a three or possibly four years course in some medical school only possibly of respectable grade In the community, outside of the university circle, you will be addressed by them as Mister, preferably as Professor, and if the latter, with apparently no other distinction in mind than that you are of a peculiar social genus which for convenience and to avoid infringement of copyright is so designated and with broad enough application to embrace with you the dancing master, the friseur and the artist in fistics It is perhaps reasonably true that in any community deprived of the academic atmosphere, that is in the average American community, there is among practitioners of medicine and surgery an indifference to or failure to grasp the purport of pure biologic research, so complete and dense as to be appalling, the more as it lies in a quarter where one might most reasonably hope for support and sympathetic concern Compared with the intelligent manufacturer, the wholesale merchant, the banker, the stock broker, the modern farmer, the average physician or surgeon carries toward the ideals of our science and of geologic science as well, so far as the results involved are not strictly commercial, an air of indifference that partakes of the supercilious

These are the chief elements in our human atmosphere with which the work of some of us must most often come into close contact As for the two influential classes —the clergy and the teachers—taken together as one class, the educators, it must be said that the reacting influence upon pure science is least of all. Either they lead where the student of biologic science can not follow or they follow where the biologist leads.

At the opening meeting of this society a year ago an effort was made to present as an introductory to our work the broader bearings of paleontologic science in a form which might be read and understood of all men It was thought, and wisely, I believe, that in this way the society might declare at the outset a platform of helpfulness to the advance of human knowledge and thus to the progress of culture Those of us who were privileged to listen to this concourse of authoritative expression on the achievements and potentialities of the science must have felt that such a summation of its purport was needed I believe this society, now in its inception, would do well to keep before its eyes as the real objective of its existence, the fact that it must make itself immediately contributory to human culture and popular instruction if it is to achieve a worthy existence In our varied special interests we are somewhat forced to overlook these broader and perhaps more humane applications in the conviction that our work is its own justification, no matter how constrained its boundaries It is even so, but it was also a singular commentary I fear on the mental attitude of some of us toward what is really the supreme objective of our work that the council of this society decided not to publish this series of illuminating papers on the aspects of paleontology—and all the more a matter for congratulation that my successor to this office assured their publication in a magazine of wider and more popular circulation than the bulletin of the society.[3]

Rarely has there been given in any one place as satisfactory a summary of the philosophy and achievement of this sci-

[3] The papers delivered at the Conference on the Aspects of Paleontology at the first (Cambridge) meeting of the society have appeared in various numbers of *The Popular Science Monthly* for 1910.

ence Competent men in all cases and in many equipped to speak with supreme authority, presented the propositions of the science from the point of view of their special lines of interest, and though on every topic brought under consideration much more might have been effectively said, yet the sum of the matter was to set before the mind, in part at least in inimitable form, the scope of the science The very nature and diversity of our interests are both our weakness and our strength Our nature is trinitarian· whenever we cease to be held together by the centripety of a common broad unity, to keep our feet together on the platform of common concern, then we fly apart into our lesser orbits If I could venture therefore out of my experience with the larger world, to urge one consideration of paramount concern on my successors in this office, it would be that on these occasions of annual reunion sight never be lost of our major purpose and no risk ever be invited of swamping our unity in the sea of details Let us not blind ourselves to the beauty of the forest by seeing only the trees in it

II THE SIGNIFICANCE OF CERTAIN EARLY PARASITIC CONDITIONS

I propose now to turn your attention with reasonable brevity, and as a conclusion of this address, to a series of considerations which I am disposed to believe, when more fully illuminated by a patient and persistent accumulation of facts, may have a wider application to interests of immediate moment to society. In the acquisition of the evidences of the earliest phases of the parasitic or dependent condition of life I have been somewhat assiduous —enough at least to realize, as every one must in entering such a field, how much remains to be acquired and how many illustrations of it still lie in our great museums unrecognized or unstudied The appreciation of the parasitic conditions of to-day depends so wholly on the adaptations in the physiology and soft anatomy of organisms, that to seek such clues as these among the rocks may seem like entering a blind cavern without a torch Volumes have been written and volumes more would be necessary to portray the aspects of dependent life in living nature from the simplest organic subjection among the bacteria to the most complicated expression in human society, and with these before our eyes I believe it possible eventually to resolve from the record of the past the problems of the origination of such dependent conditions

Whatever attitude you and I may take as paleontologists toward the conceptions of Le Dantec and his followers, that the whole panorama of life is being renewed from its beginning every day in the scenes of the present world, these at least can not cover the transactions of organic dependence in which the time element is the most illuminating factor in its existence. What I have to offer at present is a very brief statement of a few suggestive facts and of certain justifiable inferences of broader scope which rank, I believe, in the category of continuous effects

In the effort to find the real significance of this vital relation I have purposely confined my observations, so far as the fossils are concerned, to those within the Paleozoic There have entered into the literature of fossil dependents straggling and usually quite incidental records of symbiosis in the eras later than the Paleozoic, but none of these eras which approach near to the present has added, so far as my knowledge extends, any essential clues to the origination of this condition. This is naturally so, for the advanced life of the Neozoic

times too closely approximates that of the present without carrying with it the solutions suggested by the soft bodies of to-day. Our statement of inferences in this problem must be very guarded because of our being bound down only to such records as the rocks have been able to retain But lest these evidences be underestimated, let me insist that nature has dealt kindly in the retention of the most intimate structures and here again, so far as skeletal remains go, we can safely fall back on her beneficence

Purely symbiotic mutualism is of very ancient date and we find frequent evidence of commensalism far back in Paleozoic faunas, of the same type of combinations as abound in the seas of to-day Thus there are few commoner examples of mutual associations in the present sea than those of the worms and corals, the worms and sponges, sessile cirripeds and corals, and I have elsewhere indicated a number of such occurrences in the Paleozoic There are the diffuse slightly curved tubes of the worm *Gitonia sipho* which traverse the fine-celled stratiform colonies of the coral Stromatopora in the Silurian and Devonian, the spiral worm Streptindytes of graceful form in the Silurian Stromatopora and one of heavier habit described by Calvin in the large-celled coral Acervularia of the middle Devonian The open apertures of tubes of *Gitonia corallophila* are often to be seen projecting from the cups and even the sides of the coral *Zaphrentis* and its allies These are simple associations in which the partners are and have always been equally and mutually dependent, both having begun life as independent free swimming beings Among these commensal worms and corals there is one association that invites particular notice in passing, for so far as I know the present fauna, its parallel is not recorded This is the compound coral *Pleurodictyum* and its worm *Hicetes*—an association long known to students of the Devonian, but not till recently, with the help of carefully prepared materials fully comprehended *Pleurodictyum* is a compound favosite growing in small, large-celled lens-shaped coralla of the size of a brussels sprout Its commonest species are *Pleurodictyum problematicum* of the European Coblentzian and *Pleurodictyum styloporum* of the Hamilton shales of America The sessile thecated base of the corallum in both these species seems to have attached itself to the rock or mud of the sea bottom in a way that involved the formation of no special cicatrix or scar of attachment My observations lead me to the conclusion that in the Coblentzian species such form of attachment occurred in about one half of the individuals and in perhaps somewhat less than one half in the Hamilton species The rest attached themselves at the beginning of the sessile stage to some organic object, some dead shell on the sea bottom In the Hamilton species in approximately one fifth of the cases, this dead shell was usually a gastropod of the genus *Pleurotomaria* or *Cyclonema;* in the remaining four fifths, the shell was always the same shell, a species of the gastropod *Loxonema* (*delphicola* = *hamiltonensis*) I have not recorded an instance of the coral being attached to any other than a gastropod, shell These are rather broad statements but are based on the examination of several hundred examples and are an approximate expression. These bases of attachment were of course dead shells which the free-swimming coral larvæ *selected.* I have italicized the word "selected" as, however else one may be disposed to interpret the phenomenon, the act bears a strange resemblance to conscious choice. The Coblentzian *Pleurodictyum* so similar in struc-

ture as almost to veil specific difference, has however chosen differently. I can not say that I have seen a wholly convincing number of German specimens, though probably I have had opportunity, by the help of collectors and the collections of many museums, of seeing as many as any one else, and I have further had the benefit of accounts given by various workers An approximate half of the German specimens, rather more than less, are unattached For the remainder I have seen none that is not attached to the brachiopod *Chonetes sarcinulatus*[8] However these very strange facts may be expressed in accurate percentages, the palpable evidence remains, that the free and independent larvæ of these closely allied species of the same genus of coral have in one part of the world unerringly taken a brachiopod shell for a *pou sto,* while in another perhaps actually coeval sea they have not chosen a brachiopod but always a gastropod, and usually one and the same species of gastropod, for their sedentary maturity

Neither of these species of coral embryos was deprived of a choice The sea bottom of the Coblentzian and of the Hamilton stages teemed with all varieties of invertebrate remains Gastropods and brachiopods flourished alike on both An act of choice could not pertain to the degenerate and fixed adult condition of growth, but it is a matter of supreme interest that such an apparent act, in whatever psychological category it may find its place, did manifest itself in the higher stage of normal inheritance, the free and independent condition of early life.

I presume that in all the phenomena of commensalism which the early faunas of the earth have exhibited, the concurrence of the worm and the coral is the commonest Yet I have not observed it in faunas earlier than the Silurian, with possible reservation for the Ordovician The Cambrian faunas contain the vital elements necessary for such cohabitation, but have not shown any indication that this habit of interdependence had been formed so early, even though the degenerate condition of attachment had been abundantly acquired then and doubtless long before[9] I shall not enter into needless detail regarding other mutual associations of these early days, citing briefly, for convenience of reference to those who are interested, the cases of the corals *Favosites* and *Amplexus* recorded from the Niagaran of Iowa, of a worm in the bodies of the glass sponges, *Hydnoceras* and *Prismodictya* of the upper Devonian, of the barnacle *Paleocreusia* in a colony of *Favosites,* from the lower middle Devonian Onondaga limestone

In late stages of the Ordovician there are certain crinoids of the genus *Glyptocrinus* and other long-armed inadunates which when found with arms drawn together hold within them a round-mouthed snail shell of the genus *Cyclonema.* I have examined a number of these associations, but have seen in none of this age any evidence of actual attachment of the shell to the proct or any other part of the crinoid Evidently here the association was a loose one, the snail feeding on the fecal waste of the crinoid, hanging around the back door like a dog at a garbage pail It was not long after the inception of this habit, however, that an actual fixation ensued, and there are well-known cases in the faunas of the Silurian of both crinoids and cystids cemented by a muscular attachment over the proct of the host, so firmly as to hold

[8] *Pleurodictyum* of like Devonic age and with its *Hicetes* occurs both on the Bosphorus and the Maecuru River, Brazil, but we know nothing yet of its habit of fixation.

[9] At this meeting of the society Dr C D Walcott exhibited specimens of a Cambrian worm commensal with medusa

its place during all the procedure of fossilization. We can not say how enduring this condition of deject dependence was in the life of the individual of the Silurian, but the Devonian faunas and more especially those of the early Carboniferous when the crinoidea attained their maximum profusion, at once furnish abundant and well-known facts indicating that this habit had at least become so fixed that it began with a very early juvenile stage and continued probably till released by death. The domes of many crinoids in these faunas have shown by successive elliptical scars, of which the proct is the focus, left by growing shells, that the snail remained permanently and solidly devoted to this habit for probably all the later stages of its life. This is distinctly a case of true parasitism, not merely of that degeneration resulting from dependence which is universal in nature, but of absolute and abject dependence on the vital functions of another. During the maximum of the crinoids as well as of these capulids or limpets in the early Carboniferous time the attachment seems to have been not occasional, but to have attained the character of an actual habitude to which all members of the Capulidæ were liable even though not all really practised it. This singular condition endured during millions of years from its inception in the Silurian to its climax, but from the time of its general prevalence in the early Carboniferous on through the closing stages of the Paleozoic and through the long following ages up to the present we seem to lack any shred of evidence of its continuation. In very fact it seems as if in the long panorama of life through the varying phases of this great time interval, for the first time in all our knowledge of the parasitic life in all circles of existence (except where this has been influenced by the higher motives which govern humanity), that here nature had demonstrated the power in herself to rebound from such tendencies to degeneration, to give her creatures a sharp turn about and start them again on the upward path. What a splendid significance of salvation it would be for the tremendous majority of nature's apparently doomed races if there should lie herein even a slender ray of hope for the recovery of tendencies toward the normal upward progress which so many organisms have lost by the supervention of degenerate habits. We may not be entirely sure that this ray of hope for a lost nature really exists, for even though we have no evidence of the parasitic dependence of the gastropods upon the Echinoderma in all the ages of the Mesozoic and the Cenozoic, we do know that in the present sea all parasitic gastropods are parasites on the Echinoderma, the class to which the crinoids belong.

Crinoids are few to-day, to my knowledge no one has recorded on them the presence of parasitic snails, but their close relatives, the star-fish and sea urchins, are still beset by gastropods, often so modified by their degeneracy that their nature is hardly recognizable, and this parasitism too is fixed and beyond repair. In these cases which have been particularly studied by the Sarasin brothers, the parasite is still of the limpet type of structure, whether the host be starfish or sea urchin. There is a palpable vast difference in degree between this particular form of parasitism to-day and the association of limpet and crinoid in the days of the Carboniferous seas, the later irremediable, the earlier still not beyond repair, well established but clearly not beyond the control of the dependent. The great gap of positive evidence in the profoundly studied Mesozoic and Tertiary faunas which certainly should have af-

forded such factors had they ever existed, leaves us a reasonable propriety to construe the cessation of this parasitism as actually accomplished in Carboniferous times, and the recurrence of like associations among allied animals of the present an essentially new adaptation of the two. For nature has made these adaptations easily and degeneracy to the parasitic condition is one of the facile procedures of life, moving on apace with ever-increasing momentum toward race destruction Much more natural, much more logical, much better justified by well-known procedure in these easy adaptations, is such a proposition, than that after millions of ages of suppression the ancient abject dependence of the limpet on the crinoid should have reappeared as a direct inheritance out of the remote past It is to this point I would direct the major purport of this paper, for aside from all other questions of ancient parasitic conditions there is none yet of so profound biologic significance as this question raised by the parasitism of the Paleozoic gastropods on the crinoids Did the snails get over it? Did they conquer this habit of dependence and return to normal independence? Granted that the parasitic condition is but an expression of adaptation, yet it unfailingly involves degeneration Did the gastropod rebound from its degenerate adaptation and return toward the normal living which has helped to perpetuate its stock abundantly to the present in more self-reliant expression? I believe that all the positive and all the negative evidence we can now adduce on this deeply important subject favors the presumption that the habit was abandoned or at least, to speak in terms of simple casuistry, was lost We may give the counter proposition all the weight to which it is entitled, and I believe we ask too much of both evidence and presumption to seek in it a recrudescence of a transmitted acquired habit in the present after the lapse of untold millions of years between its appearances

Living nature can of its very essence present us with no such proposition as this Here the time element is of paramount importance and we are confronted then here by the single example in all known nature below man of the possible recovery of a normal upright tendency in organic living after a period of degeneration, of a case of what appears to be, deducting due allowance for possible uncovered records among profoundly studied geological faunas, an actual rebound from an adaptation to evil living back to the normal uprightness of independent life by the intervention of natural forces only I might cite to you additional interesting cases of the parasitic habit in Paleozoic organisms, but none which can now amplify the special point I have had in mind in bringing these succinctly to your notice For doubtless if nature could and did turn even an invertebrate sinner from the error of its ways once, she can do it again, she doubtless has done it more than once and her influences directed toward the demolition of such degenerating adaptations could not be restricted solely to lowly forms of life The supreme merit of the striking illustration I have been able to bring to your attention lies in the panorama of its history, its inception, its progress, climax and probable extinction Even though it may now stand alone, the argument from it could not be much altered nor greatly strengthened by supplementary cases, however it might be clarified by the verification of the negative evidence in the ages between the Paleozoic and the present. But so far is the evidence good and the logic sound that I need not hesitate to intimate that the parallelism between organic

and social parasitism is not a similitude Organic degeneracy and degeneracy in human society are not, I take it, a mere equivalence in terms, but a result in effects through stages of adaptation entirely comprehensible Sin, then, the expression of degeneracy, we may reasonably hope to believe and perhaps eventually to demonstrate from the facts of our science, is an error whose cure may lie within our own inherent impulses and whose existence may be terminated with the stronger growth of our intellectual and moral perceptions entirely within the sphere of nature herself.

JOHN M CLARKE

THE DISTRIBUTION OF THE COLLEGE MEN

THE *Yale News* has made an analysis of "Who's Who in America" for 1910–11 and finds in the book the names of 8,529 college men The data for fourteen institutions are given as follows

	Law	Medicine	Education	Science	Engineering	Ministry	Writing	Mining Eng	Journalism	Finance and Business	Government Service	Retired	Total
Harvard	158	92	175	111	25	48	77	6	59	41	43	15	813
Columbia	62	29	53	32	13	19	14	7	10	15	7	—	261
Yale	130	51	131	71	24	84	49	4	43	41	42	10	681
Michigan	57	28	69	47	12	9	17	2	8	8	24	10	271
Virginia	38	19	27	11	2	8	2	—	1	2	11	1	122
Wesleyan	14	3	37	12	2	32	4	—	6	1	7	3	121
Princeton	50	20	41	11	3	46	14	1	17	8	8	1	210
R P I	2	—	—	1	14	—	—	—	—	—	—	—	17
Amherst	23	10	65	29	5	36	12	—	10	9	4	2	205
Williams	21	5	27	10	1	30	8	—	9	4	7	1	123
Chicago	10	5	32	18	—	7	4	—	4	5	2	1	88
M I T	—	3	4	16	20	1	3	—	2	2	2	—	52
Cornell	15	9	38	39	27	7	11	—	10	3	5	3	167
Penn	32	53	29	18	11	15	10	3	11	4	9	3	200

SCIENTIFIC NOTES AND NEWS

THE officers of the American Museum of Natural History, who were elected at the annual meeting of the board, held February 13, 1911, are as follows *President*, Henry Fairfield Osborn, *First Vice-president*, Cleveland H. Dodge, *Second Vice-president*, J. Pierpont Morgan, Jr, *Treasurer*, Charles Lanier, *Secretary*, Archer M Huntington; *Acting Director*, Charles H Townsend, *Assistant Treasurer*, United States Trust Company of New York; *Assistant Secretary*, George H Sherwood By unanimous vote of the trustees, Professor Bashford Dean, Columbia University, was reinstated in his post as curator of ichthyology and herpetology The trustees also promoted Dr. W D. Matthew from acting curator to curator of the department of vertebrate paleontology. Barnum Brown, assistant curator of fossil reptiles and Walter Granger, assistant curator of fossil mammals, become associate curators

FOR the meeting of the British Association for the Advancement of Science, which is to take place this year at Portsmouth on August 30 and following days, under the presidency of Professor Sir William Ramsay, K C B, F R S., the following presidents have been appointed to the various sections *Mathematical and Physical Science*, Professor H H Turner, D Sc, F R S, *Chemistry*, Professor J Walker, D Sc, F R S, *Geology*, A Harker, M A, F.R.S, *Zoology*, Professor D'Arcy W Thompson, C B, *Geography*, Col C F Close, R E, C.M G, *Economic Science and Statistics*, Hon. W Pember Reeves, *Engineering*, Professor J H Biles, LL D, *Anthropology*, Dr W H. R Rivers, F.R S, *Physiology*, Professor J. S Macdonald; *Botany*, Professor F. E. Weiss, D Sc, with W. Bateson, F R S, as *chairman of the Sub-section of Agriculture*; *Educational Science*, Rt Rev. J E C Welldon, D D.

A PORTRAIT of Sir William Crookes by Mr. E A. Walton, has been presented to the Royal Society

PROFESSOR D. OLIVER, F R S, formerly keeper of the herbarium and library of the Kew Gardens, known for his important contributions to botany, celebrated his eightieth birthday on February 5.

MEMBERSHIP in the Prussian House of Lords has been conferred on Dr Wilhelm Waldeyer, professor of anatomy in the University of Berlin.

THE gold medal of the Royal Astronomical Society has been presented to Dr. P. H.

Cowell, for his contributions to the lunar theory and gravitational astronomy.

THE Hopkins prize has been awarded by the Cambridge Philosophical Society to Professor J. H. Poynting, F.R.S., of the University of Birmingham, for his researches on the transmission of energy in the electric field and on the pressure exerted by radiation.

THE *Journal* of the American Medical Association notes that in addition to the Nicholas Senn high school, the site for which has been secured, Chicago schools are named after the following physicians Daniel Brainard, William H Byford, Nathan Smith Davis and Charles Warrington Earle

MR. F W DYSON, F R S, astronomer royal, and Surgeon-General Sir Alfred Keogh, K.C.B., rector of the Imperial College of Science and Technology, have been elected members of the Athenæum Club for their scientific work.

M G BIGOURDAN has been appointed president of the Bureau des longitudes, Paris M B Baillaud is the vice-president and M H Andoyer, the secretary.

DR HENRY SKINNER has resigned the editorship of *Entomological News*, taking effect with the number for December, 1910 He had been editor continuously since March, 1890, since which time the journal increased in size from 168 pages and no plates to 484 pages and 14 plates per annum. The journal is in charge of the joint publication committee of the Entomological Section of the Academy of Natural Sciences of Philadelphia and of the American Entomological Society. This committee accepted Dr Skinner's resignation with regret and elected Dr Philip P. Calvert (associate editor since January, 1893) editor, Ezra T. Cresson, Jr associate editor, and Dr. Skinner editor emeritus

AT a meeting of the American Philosophical Society on March 3, Professor F M Jaeger, of the University of Groningen, will read a paper "On Fluid Crystals and Bi-refringent Liquids."

PROFESSOR L. H. BAILEY, dean of the Agricultural College of the State of New York, appeared as the ninth lecturer upon the J C Campbell Foundation of the Sigma Xi Society of the Ohio State University on the evening of Wednesday, February 8 He spoke upon the subject "The Country Life Movement."

DR. M P. RAVENEL, head of the department of bacteriology, represented the University of Wisconsin at the meeting of the American Association of School Hygiene, where he read a paper on "The Function of University Faculty Committees on Hygiene"

DR. M B. THOMAS, of Wabash College, recently lectured to the Illinois State Horticultural Society on "The Nature of Parasitic Fungi and their Relation to Their Hosts"

THIRTY-SEVEN professors from the University of Wisconsin appear on the program of the annual meeting of the Wisconsin Academy of Sciences, Arts and Letters, the Wisconsin Archeological Society, the Wisconsin Mycological Society and the Wisconsin Natural History Society, which opened in Madison, February 17 The opening address of the first day was on "The Relation between Area and Temperature of Lakes," by Dean Edward A Birge, of the college of letters and science Fifteen addresses were made by members of the university departments of geology, botany and zoology

DR EDWARD HITCHCOCK, for fifty years professor of hygiene and physical education at Amherst College, died on February 15, aged eighty-two years

PROFESSOR FRANK J PHILLIPS, head of the department of forestry in the University of Nebraska since 1907, died on February 13, at his home in Lincoln, Nebraska. He was a graduate of the Michigan Agricultural College and the University of Michigan, and had spent several years in the United States Forest Service before his connection with the University of Nebraska. He was the author of a number of important scientific papers and was one of the most brilliant teachers that the university has known

DR. M. WILHELM MEYER, known for his contributions to astronomy, and his efforts to

popularize this science, has died at Meran at the age of fifty-eight years

The death is also announced of Dr Sigmund Grundfienger, formerly professor of mathematics at Darmstadt

Herr Leopold Koppel, a Berlin banker, has given $175,000 for the erection of a research institute for physical chemistry in Berlin and will make a further gift of $87,500 extended over the next ten years for maintenance

The senate has passed the Weeks bill providing for the establishment of a forest reserve in the Appalachian Mountains by a vote of 57 to 9 The bill is applicable from Maine to the Gulf of Mexico, on the eastern seaboard It was passed by the house at the last session The bill gives the consent of Congress to the states to enter into an agreement among themselves for the purpose of conserving the forests and water supply of each, and appropriates $200,000 to enable the secretary of agriculture to cooperate with such states in giving fire protection In addition, the bill appropriates $1,000,000 for one year, and not more than $2,000,000 for each year thereafter, until 1915, for surveys, examinations and acquirement of lands located at the headwaters of streams which are being or may be developed for navigable purposes A commission composed of the secretaries of war, interior and agriculture and of two members each of the house and senate is created to acquire these lands subsequent to an examination by the Geological Survey

It is reported in *Nature* that at a special general meeting of the Geological Society of London on January 25, the following resolutions were passed (1) That the space now occupied by the museum be made available for the extension of the library (2) That it is desirable that the society's collections of fossils, minerals and rocks, with certain exceptions to be subsequently specified, be offered to one or more of the national museums, provided that guarantees be obtained that the specimens will be properly registered and rendered available for scientific purposes. (3) That it is not desirable that the society should accept money for any part of the collections, or in consideration of them. (4) That the council be empowered to approach such institution, or institutions, with the view of carrying the above resolutions into effect, and that the council shall call another special general meeting to express approval or otherwise of the arrangement proposed

The late Dr Huchard has bequeathed to the Académie de médecine a sum of $20,000 to found an annual prize to aid young students, who like his son, Marcel Huchard, in whose memory the prize is founded, are victims to professional devotion and to enable them to continue their studies

A catechism on bovine tuberculosis is the title of a circular of information issued by Dean H L Russell, of the college of agriculture of the University of Wisconsin, and Professor E. G Hastings, of the university experiment station. This bulletin presents over sixty questions gleaned from inquiries received at the college with brief answers based on the best scientific knowledge of bovine tuberculosis Complete instructions for determining the presence of the disease through the administering of the tuberculin test are given, together with hints on how to control the disease in a large herd

The operation of amblygonite mines in South Dakota during the last two years has reduced the price of lithium carbonate from $2 50 to 50 cents a pound, and large quantities have been sold at still lower prices The carbonate is the lithium product most used and is employed in making storage batteries and fireworks and for medicinal purposes. Lithium, the metal, has no practical use Lithium bromide is used to some extent in photography and in medicine. In an advance chapter of the United States Geological Survey's volume entitled "Mineral Resources of the United States, Calendar Year 1909," prepared by Frank L Hess, the occurrence and extraction of lithium ores are discussed In 1909 several carloads of amblygonite were taken from mines at Keystone, S. D., and a few carloads of spodumene were shipped from the same locality by another company Practically all

the lithium compounds prepared in the United States in 1909 were extracted from these ores.

THE department of public health at the American Museum of Natural History has equipped a laboratory to serve as a central bureau for the preservation and distribution of bacterial cultures of both pathogenic and non-pathogenic organisms, and particularly of types of new forms and varieties It is hoped that the laboratories of medical schools, colleges, boards of health, agricultural experiment stations, etc, and those engaged in biochemical work of all sorts, will furnish the museum with cultures at present in their possession, and the laboratory is now ready to receive and care for such cultures Only organisms which have been identified and which have a definite history are desired as a rule, but in the case of rare species, like the organisms of certain tropical diseases, this rule may be departed from The laboratory can not undertake to maintain more than fifteen different strains of any particular form Types of new species and varieties are particularly desired at the present time and as they may be isolated in the future The laboratory plans also to keep on file descriptions of bacterial species in print or arranged in the form of the standard card and will be grateful for copies of any such descriptions Descriptions filed in the department will be carefully preserved and living cultures will be kept in good condition, so far as possible, and will be supplied at all times without charge to corresponding laboratories and furnished so far as possible and with a reasonable charge to schools and other institutions which may desire cultures. The laboratory, of course, can not undertake to keep on the difficultly-cultivable bacteria, such as can be maintained only for a few weeks after isolation from the body; neither can it at present supply virulent cultures which rapidly lose their virulence under laboratory conditions. It should, however, be able to furnish cultures of organisms of all the ordinary types, which can be maintained under cultivation Pathogenic forms will be sent only to properly qualified persons.

UNIVERSITY AND EDUCATIONAL NEWS

IT is announced that Professor Hans Meyer has presented 150,000 Marks to the University of Leipzig for the laboratory of experimental psychology established by Professor Wilhelm Wundt.

THE New Hampshire College of Agriculture and Mechanics Arts will continue under that name, the house of representatives of the state not having approved a change to the University of New Hampshire

A SCHOOL for forest rangers to consist of a two-year course, the winters of which will be spent at the university, and the summers in practical work on the state forest reserves, or in lumbering operations in the field, is proposed to be started at the University of Wisconsin Outside the Pennsylvania ranger school and those established by the federal forest service in connection with some of the far western institutions, no attempt has been made to meet the demand for expert foresters It is thought that much of the work of the course in forestry could be given in the present departments of the colleges of engineering and agriculture The state department of forestry would probably need all the trained men that the school of forestry could turn out for a number of years

THE newspapers report that following the student disorders in Russia one hundred and twelve professors have resigned or been dismissed. It is further said that the ministry of education in order to attract professors in other countries plans to establish temporary Russian schools of law in Berlin and Paris, a school of natural sciences at Heidelberg and one of medicine at Paris

IT is announced that Dr George E MacLean has resigned the presidency of the State University of Iowa, and that Dr. Edmund A Engler has resigned the presidency of the Worcester Polytechnic Institute

MR. FRANK HOWSON, of the University of Durham, has been appointed lecturer in physiology at Sydney, New South Wales.

DISCUSSION AND CORRESPONDENCE

BOTANICAL EVIDENCE OF COASTAL SUBSIDENCE

IN a recent number of SCIENCE[1] Mr. H. H. Bartlett, writing under the above title, criticizes an earlier paper of my own concerning "The Supposed Recent Subsidence of the Massachusetts and New Jersey Coasts,"[2] on the ground that it represents hasty conclusions based on the examination of one locality where conditions are far from typical. Mr. Bartlett is of the opinion that the hypothesis there advanced to account for the appearances of recent subsidence along the coasts in question has "as a matter of fact . . . no bearing whatever on most of the evidence which has been offered."

Inasmuch as the brevity of my paper may be responsible for Mr. Bartlett's failure fully to understand it, perhaps a few words as to the development of the hypothesis presented in that paper may serve to make the hypothesis itself clearer. The writer's active interest in the problem of subsidence began a number of years ago when he was retained by counsel for the commonwealth of Massachusetts, in a case involving title to lands now below high tide level, to determine if possible the nature and extent of the recent subsidence along the Massachusetts coast. He entered upon this investigation with the belief that recent coastal subsidence in this district was a fact, well established by the studies of various students of shoreline phenomena; and his efforts were mainly directed toward ascertaining whether the subsidence was continuous in time and regular in rate, or whether it was intermittent and at varying rates. In connection with this investigation examination was made of numerous publications on recent changes of level in the United States and Canada, and many foreign reports on the same topic; and so fair familiarity with the literature of the subject was gained.

Even before undertaking the above investigation, certain geologically recent changes in the form of the shorelines about Boston had attracted the writer's attention; and in the succeeding years more or less consideration has been given to this subject. Several of his students have made special studies of selected areas along the coast, in each case giving attention to the problem of coastal subsidence. Their observations and his own, supplemented by studies of maps of certain areas not visited, led the writer to conclude that the coast had remained essentially stable for a long period of years, and that if any considerable subsidence had taken place, it must have occurred long ago.

The botanical evidence of recent subsidence was still a puzzle. Manifestly, the uppermost layers of the *Spartina* turf, and the stumps of cedars and other trees exposed in the marshes, could not be due to a remote subsidence, even if the lower layers of turf and the more deeply buried stumps had been depressed long ago. Careful attention has been given to this phase of the problem, and in this connection let me express my great indebtedness to Dr. Charles A. Davis, who gave me the opportunity to accompany him on several of his field excursions, and who took the time to visit with me two or three localities where I had studied the physiographic features of the shoreline. On these excursions I became fairly familiar with the botanical evidence of subsidence, and with the interesting methods of investigation which Dr. Davis has developed for the study of salt marsh deposits. By means of the ingenious peat sampler devised by Dr. Davis, the writer has endeavored to increase his knowledge of the structure of several of our marshes; and one of his students has made a detailed series of sections across the marshes at the mouth of the Neponset River, which will be referred to in a future publication.

As a result of these studies, it seemed to the writer that while the lower portions of the marsh deposits might indicate subsidence in times long past, the upper portions (the portions which furnish supposed evidence of *recent* subsidence) might be explained in either one of two ways: they might represent a resumption of the downward movement of the coastal region in recent times, after a long

[1] SCIENCE, N. S., XXXIII., 1911, 29–31.

[2] SCIENCE, N. S., XXXII., 1910, 721–723.

halt; or they might be explained as the result of local fluctuations of marsh level or of tide level, independent of a downward movement of the coastal region. The long halt in the supposed downward movement seemed to be demanded by the physiographic evidence.

Observations in the Scituate-Marshfield region revealed a cause of fluctuations in high tide level which appeared competent to explain most, if not all, of the evidences of recent subsidence. After a consideration of the tidal conditions along the Atlantic coast, and a study of the nature of the high tide surface about the coasts of England, as reported by Wheeler and others, the conclusion was reached that the conditions in the Scituate region had been repeated in a greater or less degree all along our coasts in recent geological times, as a necessary consequence of the nature of the high tide surface and the changes effected by wave action on all shores, particularly those composed of poorly consolidated materials. The cause seemed competent to explain a deposit of peat varying in thickness from a few inches to a possible maximum of 15 feet or more, according to the former range of the tides. As all of the supposed evidence of *recent* subsidence on the Massachusetts and New Jersey coasts are, so far as known to the writer, capable of explanation on the basis of a fluctuating high tide surface, and as the conditions on those coasts make such fluctuations in the past a seeming necessity, and as the physiographic evidence, on the Massachusetts coast at least, points to a long period of coastal stability in recent times, the conclusion seems reasonable that, while subsidence in the past may have occurred, the evidence of recent subsidence in these two areas is not decisive. Further study convinces me of the correctness of that conclusion. But whether it is correct or not, it was not reached with undue haste, nor was the botanical evidence of subsidence "lightly disregarded."

When a problem that has been discussed for many years, on the supposition that it involves but x factors, is found really to involve $x+1$ factors, all of the earlier conclusions should be carefully reconsidered; not that they are necessarily wrong, but because it can not be known that they are right until the additional factor is fully considered along with the others. The problem of recent subsidence of the Atlantic coast has long been discussed, but the importance of a high tide surface which fluctuates with changes in the form of the shoreline, as a possible explanation of this apparent subsidence, does not appear to have been considered in the published discussions of the problem. It is an element of possible value in all cases of tidal shores which are irregular in outline or which are bordered by barrier beaches. Hence all conclusions which have been reached in regard to recent subsidence in such cases ought to be revised in order to take this element into account. What the result of revision in each case will be can not be foretold, and for this very reason the revision seems the more necessary. The writer is attempting such a revision for several localities, without prejudice in favor of any particular conclusion, and in most of the cases without any idea as to what the final result will be.

My statement as to the inconclusiveness of the evidence of recent subsidence on the Massachusetts and New Jersey coasts, was made after a careful reading of Mr. Bartlett's very interesting paper on the sub-marine *Chamæcyparis* bog at Woods Hole, Mass. Although this paper presented a most ingenious and interesting argument in favor of recent subsidence, the validity of the argument depended upon certain assumptions which seem to me untenable. It was not the object of my brief paper to discuss the voluminous evidence in favor of recent subsidence, but rather to make a short preliminary announcement of an hypothesis which appeared to be of considerable importance, for this reason I did not deal specifically with Mr. Bartlett's observations. Full attention will be given to all accessible evidence in favor of recent subsidence in a future publication.

A careful reading of Mr. Bartlett's criticism of my paper leads me to think that he has failed to discriminate sufficiently between low-lying peat deposits which may be of consid-

erable antiquity, and the uppermost deposits unquestionably of modern date which alone can be invoked as evidence of recent subsidence It would appear, also, that he has not clearly understood my paper, for it is otherwise difficult to account for such statements as "the hypothesis of a fluctuating high-tide level has no possible application" to the botanical evidence of present subsidence as presented by Dr Davis, or that the hypothesis "has no bearing whatever on most of the evidence which has been offered" Surely if the height of ordinary high tides gradually rises one or more feet as the result of changes in the form of the shoreline without change in the level of the land, this increase in tidal height will produce all of the phenomena which would be produced by actual subsidence of the land, "now going on" The task which confronts the student of shoreline changes involves a discrimination between different causes producing like results, and the best method of making such a discrimination is, in the opinion of the writer, to deduce the character and magnitude of the results which each hypothetical cause is theoretically capable of producing under the varying conditions which exist along an irregular coast, and then to compare the deductions with the actual phenomena as observed in the field So far as I have carried such an analysis for the Massachusetts coast, the evidences of supposed recent subsidence are all capable of interpretation on the basis of a fluctuating high tide surface, whereas physiographic features of much importance seem incompatible with the theory of continued recent subsidence

D. W. Johnson

MIASTOR AND EMBRYOLOGY

Reproduction by insect larvæ, a form of parthenogenesis known as pedogenesis, is extremely interesting. The writer was fortunate last fall in finding, in the partially decayed chestnut bark of a rail fence, numerous *Miastor* larvæ, forms not previously recognized in this country, though several species and representatives of allied genera have been studied by a few Europeans. *Miastor* larvæ and their allies should be of great service to teachers of zoology and biology, since they admit of the study at first hand of this interesting phenomenon It is possible, with a no more elaborate outfit than an ordinary student's microscope equipped with a three-fourths objective, a microscopic slide and a few cover-glasses, to observe the vital activities of the young larva, to see the muscular, respiratory, digestive and nervous systems, to identify the ovaries and to watch the gradual development of the semi-transparent embryos within the body of the living mother larva Furthermore, these forms are well adapted to more exact histological methods, being soft and therefore excellent subjects for serial sections and stains, particularly as it is comparatively easy to secure from one colony a series of individuals representing different stages of development

Aside from the interest attached to their morphology and biology, there are other considerations which should appeal strongly to the teacher of zoology These larvæ are widely distributed and, with an understanding of their habits, there should be little difficulty in finding them They are small, and a piece of wood six inches long, three inches wide and half an inch thick, may contain or produce enough material for a fair-sized section or class The larvæ are prolific and, under favorable conditions, would probably multiply at any season of the year This is certainly true of the fall, the early winter and the spring. They can be kept alive for at least a month in microscopic cells, and with care a larval generation will develop in such restricted quarters. We have kept larvæ healthy and multiplying for nearly three months with nothing more elaborate than a moist piece of decaying wood clamped lightly to an ordinary microscopic slide and kept in a moist, dark box. Many of the larvæ were content with conditions on the surface of the wood, next the glass, and were therefore easily observed These remarkable larvæ are very hardy; prolonged dryness simply results in a suspension of activities, while they are quite resistant to an abundance of moisture. Embryos will continue their development in mother larvæ even

though the latter be kept for weeks in a sealed cell filled with water. It is even possible to make very satisfactory photomicrographs of living embryos within the mother larvæ, while there is not the slightest difficulty in observing the movements of those nearly fully developed before their escape from the mother integument. With our present knowledge we see no reason why artificial colonies of this insect might not be established in the vicinity of a zoological laboratory and maintained with very little or no attention from year to year, if not for a decade or more. A detailed account of this species, with a number of illustrations will appear shortly in the writer's report for last year.

E. P. FELT

TREMATODES OF THE DRY TORTUGAS

MY friend Albert Hassall has called my attention to two of the new generic names which I employed in a recent paper on the Trematodes of the Dry Tortugas.[1]

The generic names *Didymorchis* and *Mesorchis* are preempted, thus making it necessary to invent other names to take their place. I therefore propose for *Didymorchis* the name *Pycnadena* (πυκνὸς packed close, and ἀδὴν a gland), and for *Mesorchis* the name *Antorchis* (ἀντίος opposite, and ὄρχις).

These two specific names hence become *Pycnadena* (n. g.) *lata* (Lt.) and *Antorchis* (n. g.) *urna* (Lt.)

At the suggestion of Mr. Hassall I take advantage of this opportunity to state that *Deradena ovalis*, *Hamacreadium mutabile* and *Genolopa ampullacea* are the type species of their respective genera.

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WASHINGTON, PA.,
January 23, 1911

[1] "Helminth Fauna of the Dry Tortugas, II, Trematodes," Papers of the Tortugas Laboratory, Carnegie Institution of Washington, Vol. IV, pp. 11–98, plates 1–28; issued December 16, 1910.

QUOTATIONS

COMMERCIALISM IN EDUCATION

THAT the methods of higher education are in a state of transition in this country appears evident from the pedagogic innovations made and the many more proposed during the past several years. On the one hand, colleges of higher standing are elevating their curricula to a real professional plane, apparently having at length found it too difficult, to say the least, to instruct in the same course men for such different callings as dynamo tender and consulting engineer. On the other hand, some schools are frankly revealing that their aim is to serve, not the interests of the student, but solely those of the employer of technical graduates, even though education directed primarily to this narrow purpose may unfit the subject for obtaining the most out of life spiritually, through lowering his ideals and curbing his ambitions, and financially, through making him a mere serf to an industry. A concrete illustration of the haphazard condition of thought concerning technical education is afforded by a recent report of the Carnegie Foundation for the Advancement of Teaching on "Academic and Industrial Efficiency," prepared by a well-known and doubtless capable "efficiency engineer," whose business is concerned with the economical administration of manufacturing establishments.

While we have no quarrel with the efficiency engineer as such, nor with his efforts in the course of business to report upon any problem which his clients may desire investigated, we can not refrain from expressing astonishment at the frame of mind of one who would direct the application to instruction in science of the canons appropriate for running a purely money-making business. The possibility of such a distortion of view is the most serious criticism that could possibly be launched against American educational methods. As well put a skilful and successful sausage maker at the task of criticizing the manufacture of astronomical telescopes. An institution for training young men in science, whether pure or applied, is not a money-getting concern. Its product is not sausages, but the advancement of human intelligence, which may or may not be applied to gainful objects. Even in the narrowest technical sense it does

not turn out a standardized product of salable packages of information, but an infinitely variable and intangible thing the importance of which to the world can not be measured by the demand for it reckoned in dollars and cents The world ultimately owes far more to the institution which produces men who guide the world's destinies in any department of activity than it does to the graduate factory that adds yet more to the rank and file of the mediocre This at least is the situation regarding the very class of institutions the investigation of which was undertaken in the report before us Its whole tenor was to lay emphasis upon the destruction of the academic freedom and initiative that is necessary to the advancement of human intelligence and to promote that kind of organization which, under the disguise of uniformity and system, effectively suppresses progress It is an application to educational institutions of the methods too common in American manufacture, which insure a large output of the tolerable rather than a small output of the desirable—*The Electrical World and Engineer*

SCIENTIFIC BOOKS

Theorie physico-chimique de la vie et générations spontanées Par STÉPHAN LEDUC, professeur à l'école de medicine de Nantes Paris, A Poinat 1910

Life as a physico-chemical process, and the analogy between living and lifeless, would possibly have been a better heading for this little book of Professor Leduc, for it does not consider spontaneous generation in the fashion which the reader is apt to expect from its title On the other hand, it may well be that the post-Pasteurean biologist is over-sensitive as to the words "spontaneous generation," and he is apt to give them in latter days a cabalistic meaning. he inclines to dismiss the rare papers which deal with the theme as anachronisms—and he is careful not to recommend them to publishers Even the French Academy has become so modern that it will not admit to its shelves any treatise which deals with this "exploded theory"!

Nevertheless, a whisper comes occasionally out of the wilderness and reminds us that this is the problem of all biological problems and that it is still neglected Perhaps our conscience is touched by the feeling that if we are consistent evolutionists we must have some manner of faith that the living came from the lifeless, and that, in the pursuit of biological happiness, we have been drifting in past years towards vitalism in some type or another We recall too, that in the last decade, steps have been taken in the analysis of biochemical phenomena, in matters of enzymes, catalyzers, ions, tonicity and similar physical facts which have all an intimate bearing upon organisms and are paving the way for a new biological era After all, many of us are convinced mechanists, and there should therefore be no reason why a book like Leduc's, title and all, should not be welcomed It is certainly the first work to bring up to date the documents upon which a synthetic biology—as distinguished from descriptive and analytical—may be founded

Let us see how his theme is handled: There is as yet no satisfactory definition of life: in spite of the efforts of many biologists, we know it by its presence or absence, by phenomena of nutrition, sensibility, growth, organization, reproduction, processes all of which are known in some degree in the inorganic Moreover, as Leduc declares, life is in itself different in quality in its different manifestations in various organisms, thus he leads us to infer that the life of man differs more widely from the life of a protozoan than the life of the protozoan from the "life" of liquid crystals, for example Life is to be studied as the transformer of matter and energy, it is a specialized phase of matter, the organic as opposed to the inorganic, and like a current it changes ephemerally. Its expression can best be studied in nutrition and in morphogenesis And these are the lines of study which the author has developed. Nutrition is in essence chemico-physical, especially concerned with the phenomena of contacts between fluids of different characters, whether electrolytic, osmotic, colloidal, crystalloidal In this connection he considers the laws of solutions,

matters of molecular concentration, osmotic tension, cryoscopy, periodicity, Ostwald's surface energy, relations to thermodynamics, diffusion, fields of force, all considered as elementary factors which enter into the synthesis of organic phenomena In the matter of diffusion Leduc's experiments show curiously close parallels with organic processes, producing geometrical forms, circulation of "cytoplasm," "life" which survives freezing or drying, pseudosegmentation of a "germ," and phantoms of karyokinetic figures Especially striking are osmotic growths, which are unquestionably the most complete parallels between the lifeless and the organic which have been devised Following Leduc's formulæ one may cause "organisms" to grow which are curiously like algæ or fungi Leduc points out that they will grow roots, stems and "fruit," the last sometimes appearing quite different in color The growths have their periods of "youth, maturity, senility and death," they exhibit periods of activity and rest, they show cell-like divisions, definite form relations, and a circulation of their fluid contents, they will repair wounds, and show responses to external and internal stimuli Peculiarly sensitive are these colloidal osmotic productions to changes in milieu thus those "growing" around the sides of a jar will occasionally behave differently from those in the middle. Each salt, it appears, has its specific morphogenic properties With some salts the "productions" are first attached they then become amœboid and motile, sometimes forming spicules at the surface The degree of concentration of the solution, also, determines sensitively the branching or the heaviness of the growth, the outcome of reactions which Leduc compares, by numerous chemical formulæ, to metabolism.

Altogether Leduc's book is interesting and it deserves to be carefully read We need not admit that it is biology; but we must admit that the inorganic conditions which here are given detailed consideration have occurred and are occurring constantly in organisms. And we shall be apt to admit that the synthetic method promises results which will prove of great value Leduc would be the first to agree that living substance may not be synthetized for ages, if at all But each advance brings the goal nearer, in the solution of single problems, and even of their separate components Leduc points out the immediate task of synthetists, and an essential one, is not the artificial production of albumenoids, but of a chlorophyllian substance which will decompose carbon-dioxide dissolved in water and be capable of assimilating carbon In this direction one recalls the interesting notes of Matthews and of McPherson in recent numbers of SCIENCE

BASHFORD DEAN

Praktikum der Bakteriologie und Protozoologie Von KISSKALT und HARTMANN Zweite, erweiterte Auflage Zweiter Teil Protozoologie Von Dr M HARTMANN. Pp vi + 106 Mit 76 teils mehrfarbigen Abbildungen im Text Jena, Gustav Fischer 1910 M 4

The task of securing adequate laboratory material for instruction in protozoology has been considerably simplified by the "Praktikum" of Kisskalt and Hartmann The author of the second part, Dr Hartmann, is the director of the laboratory of protozoology in the Royal Institute for Infectious Diseases at Berlin, a pupil of Professor R. Hertwig and the successor of Schaudinn as editor of the *Archiv fur Protistenkunde* The work is therefore authoritative and reflects the current practise in one of the greatest centers of research. The hand-book is written primarily for the medical student and includes only parasitic forms and especially those of medical interest It is not a book therefore primarily for the biological laboratory though the range of forms it discusses is sufficiently wide to make the work indispensable to every student of the protozoa, and of greatest value in all laboratories in which the protozoa are studied

The second edition has been considerably enlarged by the addition of a section on the technique of investigation in protozoology and by a chapter on the Myxosporidia and the Sarcosporidia. A number of new parasitic

types, principally from culture animals, have been added, including *Amœba lacertæ, A diploidea, Entamœba muris, E. tetragena, Trichomonas muris, Lamblia* (and *Octomitus*) *muris, Leucocytozoon siemanni, Proteosoma præcox* and *Balantidium coli*

The plan of treatment is comprehensive, including general introductions to each group, and detailed accounts of the morphology and life history of each of the forms discussed together with directions for securing, controlling, cultivating and preparing the material for study Illustrations often in color, illustrate the various stages and assist materially in the interpretation of laboratory material Brief bibliographies of a few pertinent papers are appended

It is to be regretted that the student of *Babesia canis* is left uninformed of Nuttall's work, that Fantham's work as well as Schellack's on spirochætes is not cited and that the sexual phase of the cycle of *Trypanosoma lewisi* is described as reported by Prowazek in *Hæmatopinus* without any hint as to the reserve with which his conclusions on this point have been generally received This lack of caution is all the more regrettable in the light of Minchin's experiments with fleas as carriers and Doflein's recently published results of his experimental cultures and his conclusions as to the necessity of caution in interpreting stout and slender forms as sexual gametes and their conjunction as conjugation

No chapter on technique of parasite flagellates is complete either historically or technically without calling the student's attention to the culture methods of Novy and MacNeal. Such omissions as these are hardly to be condoned by the fact that the author is writing primarily for the German student.

The figures are often original and are uniformly excellent. The condensed but comprehensive and lucid account of the significant features of the structure and life history of the important pathogenic and parasitic types available for laboratory use will be of greatest assistance to the student in this difficult field.

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TRIPHENYLMETHYL

SINCE modern methods of formulation were established, organic chemists have been able to represent the many thousands of compounds, whose constitution has been elucidated, by formulas in which the carbon atoms are always tetravalent The single exception was carbon monoxide, CO, in which the carbon is necessarily represented as being bivalent

In view of these facts it was natural that Gomberg's discovery of "triphenylmethyl," $(C_6H_5)_3\overset{*}{C}$, should arouse widespread interest, because, if it be correctly formulated, the carbon atom marked * is trivalent During the ten years which have elapsed since Gomberg's discovery was first announced, a very large amount of work has been carried out in order to elucidate the true nature of triphenylmethyl The most important contributions, which are summarized below, have been made by Gomberg himself, by A E Tschitschibabin, A von Baeyer and more recently by W. Schlenk[1] and his co-workers in Baeyer's laboratory

"Triphenylmethyl" is prepared by the action of certain metals, such as zinc, on triphenylchloromethane, $(C_6H_5)_3CCl$, the metal simply removes the chlorine atom "Triphenylmethyl" exists in two forms, a white, solid modification, which is relatively stable, and a soluble yellow form exhibiting very great chemical activity This colored variety has a molecular weight corresponding to the simpler formula, $(C_6H_5)_3C$

As regards the colorless material, the facts pointed to its being hexaphenylethane, $(C_6H_5)_3C\cdot C(C_6H_5)_3$, but many chemists hesitated to accept this view, chiefly, perhaps, for the following reasons. The substitution of phenyl groups for hydrogen in hydrocarbons results, in general, in an increase in the stability of the product, consequently, in passing from ethane, $CH_3\cdot CH_3$, to hexaphenylethane, $(C_6H_5)_3C\cdot C(C_6H_5)_3$, we should expect to obtain an inert substance, but we find that the "hexaphenylethane," mentioned above, is so unstable that its mere solution, at the ordi-

[1] *Ber d. chem. Ges.*, 43, 1753, 3541, 1910.

nary temperature, causes its decomposition into "triphenylmethyl," $(C_6H_5)_3C$

An investigation of the ethanes containing a smaller number of phenyl groups, from one up to five, would obviously be calculated to throw light on these points This work has been carried out and it has been found that a very stable compound, which was formerly regarded as being hexaphenylethane, actually possesses a different constitution It has also been shown that, in certain respects, there is a decrease in stability and an increase in chemical reactivity as the number of phenyl groups in the ethane molecule becomes greater Thus, for example, pentaphenylethane, $(C_6H_5)_3C \cdot CH(C_6H_5)_2$ is decidedly less stable than tetraphenylethane, $(C_6H_5)_2CH \cdot CH(C_6H_5)_2$

The final link in the chain of proof has been furnished by Schlenk, who has just shown that if the pentaphenylethane be heated with a neutral solvent of high boiling point, it is decomposed into triphenylmethyl and tetraphenylethane, in the manner indicated by the dotted line in the formula,

$$(C_6H_5)_3C \vdots CH(C_6H_5)_2,$$

the tetraphenylethane results, of course, from the combination of two of the groups, $CH(C_6H_5)_2$ It follows, therefore, that there is no difference, in principle, between the behavior of pentaphenylethane and hexaphenylethane towards solvents, when in solution, both give triphenylmethyl, the latter at the ordinary temperature, the former only when it is heated

In view of these results there is no ground for doubting that the colorless solid obtained by Gomberg is really hexaphenylethane, $(C_6H_5)_3C \cdot C(C_6H_5)_3$, and that its passage into solution, at the ordinary temperature, suffices to resolve it into two molecules of colored triphenylmethyl, $(C_6H_5)_3C$

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SPECIAL ARTICLES

SUGGESTIONS AS TO THE CULTURE OF BUTTERFLIES

BUTTERFLIES, with their clear-cut color patterns and brilliant hues, their remarkable polymorphism seen in the occurrence within a single species of two or more seasonal forms, or of melanic, albinic or other varieties often limited to individuals of one sex, furnish a most inviting field for the student of evolution and heredity The fact that in America, at least, no precise and long-continued work on heredity in diurnal lepidoptera has been undertaken hitherto is probably due in part to the belief that the mating of butterflies, occurring usually in the air, would be difficult to bring about in small cages; though the mating of moths under such conditions is generally known to be an easy matter It is my purpose in this article to correct this false impression in regard to the mating of butterflies, and to make other suggestions as to methods of caring for this dainty live stock, of marking individuals to indicate their pedigree, and of preserving them in a more compact, permanent, convenient fashion than the usual impalement on long pins in bulky drawers or boxes

One who undertakes the study of the heredity of butterflies may of course begin either with live wild females, presumably already impregnated, or with eggs already laid, with larvæ, or with chrysalids. For transportation over long distances chrysalids, or eggs upon the food plant, are usually to be prefered Living plants with roots intact and leaves covered with eggs may be shipped in tin boxes by mail. But often only the imago can be obtained In this case, and always, if the distance is not too great, sending live butterflies by mail in strong, cylindrical tin boxes lined with moist blotting paper that is held firmly in position is to be recommended. I have found that *Colias philodice*, shipped 150 miles in this way, and shut up closely for eighteen hours, stands the journey well, and lays abundantly, if well fed with sweetened water upon arrival.

For purposes of identification it is of course necessary for the student of heredity to label each living adult butterfly. This is readily done by writing the sign of the family and individual with pen and ink upon the under

surface of the hind wings. Since aqueous ink will not flow readily enough, the pigment used should be dissolved in 50 per cent alcohol, and applied with light strokes of a stub pen Anilin dyes are convenient, as they are readily soluble and can be obtained in almost any color, but for general use any carbon ink that is not precipitated by mixing with 50 per cent. alcohol is preferable, because more permanent. The live butterfly, held firmly with smooth-tipped entomologists' forceps clasped across the fore and hind wings close to the body, objects very little to light strokes of the pen, and the alcoholic ink dries quickly

For the designation of a family from a single mating, that is, the progeny of one female, I use a small letter, reserving the corresponding large letter for the original wild female The individuals of each family as they pupate, or, if more convenient, as they emerge from the chrysalis, are marked with arabic numerals written at the right of the family letter, like an exponent In butterflies of course these numbers may run up to over 100 In one family of *Colias philodice* that I raised during the season of 1910 there were 128 brothers and sisters Suppose this family were the offspring of the wild female, "A," and were called "a" The last to pupate (or to emerge) would be "a^{128}" To facilitate the handling and recording of large families, it is sometimes well to raise the successive batches of eggs laid by a single female separately, designating each successive lot with a numeral written as a coefficient, so that $2n^{10}$ would mean the tenth butterfly to pupate (or to emerge) in the second lot of eggs laid by the mother of family "*n*" The name and pedigree of this female, and that of her mate, would be recorded, of course, at the head of the sheets on which the dates of pupation and eclosion of their offspring are set down.

No elaborate outdoor quarters are needed for keeping and mating live butterflies. The air of the laboratory needs only to be fresh and fairly moist, as that of the ground-floor rooms of large buildings of brick or stone is likely to be in summer The parched air of a steam-heated room, or of one upon an upper floor and flooded with direct sunlight, is more fatal to butterflies than complete absence of food in a moist atmosphere Bottomless cages 15 inches in length and breadth and 10 inches high, consisting of a simple frame of pine strips covered inwardly with cotton mosquito netting, are of ample size for *Colias philodice*, serving as a vivarium for the pupæ, as an enclosure for mating, and as a cage for the female during egg-laying, if the food plant is small enough to be covered by a frame of this size The use of wire screening is not to be recommended for adult butterflies, as it soon wears out and disfigures the wings that beat upon it A frame of this sort covered with cheese cloth, or better with the material known by milliners as frame covering, makes an excellent breeding cage for even the youngest larvæ.

The imago that has just crawled up from its chrysalis rests until the blood flows from the abdomen into the tiny pupal wings In *Colias philodice* this requires about five minutes, but the wings after reaching full size remain limp for about a half hour, and marking should be deferred until they harden Then the males of each family may be placed together in one cage, the females in another On the day following eclosion they will be ready to feed, and bouquets moistened with a solution of honey and water, or brown sugar, should be placed in the cages

It is surprising to a beginner to see how readily live butterflies may be handled in the absence of direct sunlight or intense diffuse light. Even out of doors, after sunset or in the early morning, they may be allowed to creep upon the finger wet with sweetened water, and feed They are attracted by a warm moist hand, as by a flower, and on holding them by the costal margin of the wings with one hand, and allowing them barely to touch with the feet a moist finger or palm of the other, they may be stimulated to extend the tongue and begin feeding Once feeding has begun, they may be moved to a generous drop of honey and water and allowed to drink their fill. In dull, cold weather butterflies neither feed nor lay, and it is necessary in midsummer, when metabolism is rapid, that

individuals to be used in breeding should have at least one square meal a day, served either in the early morning or evening, when they can be handled without danger of escape. In case they are actively flying during the day, and visit the moistened bouquet provided for them, they will of course feed themselves, but they are more strongly attracted toward the source of light than toward food, so that, if only slightly active, they may not reach the food supply at all. This is one reason against the use of large cages. They do not go in search of food, as the bee seems to do, but, stimulated by light to activity, they find it almost by accident. Hence they must be kept near the food.

The same reason applies to the use of small cages for mating. The larger the cage, the smaller are the chances that two individuals will meet. I began my experiments by turning butterflies loose in a large screened veranda, strongly lighted only on one side. Under such conditions their attraction towards the light absolutely controlled them. Each went his or her own way, paying not the slightest attention to the others. If several males and females of the same species are placed in a cage of the dimensions noted above (10 inches high and 15 inches square) or 15 inches in all three dimensions, and kept in the direct sunlight, or, if the temperature is high enough, in strong diffuse light, some matings may be expected. As soon as a couple are mated they should be removed to a separate cage, and their numbers noted. Mating continues in *Colias philodice* for over an hour, usually for about an hour and a half, and often two or three hours, so that there is little danger of promiscuity when large numbers of both sexes are placed in the same cage, if properly watched. One male often can be mated on successive days with several females.

Fertilized females often begin to lay on the day after mating. They will lay quite well indoors under warm, sunny conditions, provided they are well-fed, but in any case the food plant on which they lay should be growing, so that the minute larvæ, upon hatching, will find fresh food awaiting them. The most convenient way to obtain the eggs and rear the larvæ of *Colias philodice*, for example, is to place the butterfly in a cage over healthy clover growing on a lawn that is free from ants and slugs.

The food plants and feeding habits of larvæ are so varied that few general directions can be given for their care. Caterpillars that feed on coarse leaves that wilt slowly when gathered may be kept in large, flat, cloth boxes, like those that are used at the Gypsy and Browntail Moth Laboratory at Melrose Highlands, Mass. But the leaves of most food plants of butterflies soon become wilted and dry under such conditions, and it is preferable to enclose the growing plant in a cage, or a branch of the shrub or tree in a bag of cheese cloth. If kept in close glass vessels to prevent evaporation, or even in large moist vivaria, there is danger in *Colias philodice*, at least, of infection with an intestinal bacterial disease that may kill a large proportion of both larvæ and pupæ. So a good general rule is to keep the larvæ upon their food plant out-of-doors, and well screened from insect parasites and birds.

Pupæ should be carefully guarded from mice and slugs, and if either are at all abundant the chrysalids should be taken indoors. *Limax maximus* will gnaw through a fine cloth netting on the inside of which a pupa rests, and eat the chrysalis, leaving a small hole through the screen, the margin of which is blackened with the salivary juices of the slug, which apparently contain sulphuric acid.

The student of the genetics of butterflies will hardly be content with the ordinary museum methods of mounting specimens upon pins stuck into cork. Greater compactness, perfect safety from museum pests, and quick accessibility to both surfaces of the wings are needed. The patent Denton mounts for individual specimens satisfy these requirements well, but they are expensive for use in large numbers and, though vastly superior to the ordinary pin-cushion method, are not convenient to handle when huge families are being examined and compared, because each specimen must be picked up separately. All these needs, however, are met by a simple form of

case which the present writer has used with much satisfaction

The mount consists of a rectangular, wooden frame of any desired size (e g, 10 × 12 inches) made of pine strips three eighths of an inch square in thickness, mitered or mortised at the corners, holding apart two sheets of glass corresponding in size to the outer edge of the frame, one for the top and one for the bottom of the mount, which is bound together with passe-partout 1¼ inch wide As for the glass, old photographic plates, 10 × 12 inches in size, cleaned with caustic potash solution, are convenient in dimensions, thin and light, and of good quality.

Each butterfly is prepared by stretching and drying it upon its dorsal surface, pinning it temporarily until it has been made fast with strips of paper. The wings of the dried specimen must lie flat, or be inclined slightly ventrad, but never dorsad It is then fastened, with a small drop of thin liquid glue applied to the dorsal surface of the thorax, to the sheet of glass that is used as the upper pane or cover Small strips of sheet lead (about 1 inch × 1½ inches), bent into an arch, make a convenient weight to set astride the wings until the specimen is well fastened to the glass. The pane is then inverted over the frame, and glued to it The lower sheet should not be glued to the frame, but fastened to it only by the strip of passe-partout, 1¼ inch wide, which is used to hold the two panes of glass together and seal the mount. If a specimen should get loose, the bottom glass may be easily cut away, repairs made, and the case sealed with fresh passepartout. If the upper pane should get broken, it is a simple matter to remove the specimens, using steam when necessary, and remount them. Care should be taken in the preliminary stretching of the specimens lest the feet should project more than necessary, so that, when the case is put together, they come into contact with the lower plate, and loosen the attachment to the upper. For ordinary purposes, however, it is only necessary to trim off the tips of a few that project excessively.

Seven hundred butterflies of the size of *Colias philodice* can be filed away in the space of a single cubic foot, in the mounting frames just described, each case measuring 10 × 12 inches in breadth and length and one half inch in thickness, and containing 25 specimens They are sealed from dust and vermin, and easily examined on both surfaces in groups of convenient size

A rich field for conquest awaits any one who chooses to leave the beaten tracks of entomology and scout among the fastnesses of experimental evolution When one considers the remarkable results that have been accomplished single handed by such observers as Standfuss, Tower, Doncaster and T H Morgan, not to mention many others, the possibilities achieved in this field if the huge army of observers already interested in insects should attack in an organized way the problems of variation, the inheritance of acquired characters, mutation and natural selection, polymorphism and sex, mimicry and protective resemblance, can hardly be overestimated Desultory observations of the strolling naturalist will not help much in this conquest, but long-continued breeding of carefully selected strains under well-controlled conditions can not fail to win valuable results

Entomological societies and journals of the future, in order to contribute effectively to the real advancement of science should organize cooperative plans of research along these lines, and enlist the services of the countless observers whose random notes now fill their archives

JOHN H GEROULD

VARIEGATION OF EUROPEAN ALFALFAS

As a part of the extensive investigations being conducted with alfalfa at the Dickinson, North Dakota Sub-station, a series of European alfalfas was planted in the nursery in 1909 A study of some of the plants in 1910 revealed the presence of variegation in flower coloring. This was expected to a certain extent As a preliminary to the determination of the correlation of the variegation to other characters, both physiological and morphological, the percentage of variegation was determined for each strain or planting

Variegation is a feature of certain alfalfas, which undoubtedly indicates that at some previous time at least one parent has been the yellow-flowered sickle lucern, *Medicago falcata*. The flowers of the pure *Medicago sativa* retain their original color from the time of blooming to the time of withering. The color may range from nearly white to some shade of violet, but the color, whatever it may be, remains stable during the period of bloom. The flowers of *M. falcata* are of a chrome yellow, and remain constant, as do the flowers of *M. sativa*. The flowers of the hybrids of these two plants show a range of coloration during bloom, before withering, which, in extreme cases, runs from rich pansy violet through lettuce-green to coppery-yellow. Even in plants having apparently but a small proportion of *falcata* parentage this variegation of color is retained, though in a manner much less pronounced than in the case instanced.

The alfalfas under experiment which are given below were secured through the United States Department of Agriculture. Many of them were obtained from abroad through the energy of Mr. Charles J. Brand, of that department.

The number at the left of each strain is the seed and plant introduction number of the Department of Agriculture. The names are the translations of the German common names, or in many instances, the locality whence the seed was obtained is alone given. The total number of plants of each strain and the percentage of variegation are given.

A supplementary table is given which groups the alfalfa strains according to their geographic origin or to the name borne by them in Europe.

Summarizing the foregoing table we have the following:

S. P. I. No.	Name and Source	Number of Plants	Per Cent Variegated[1]
25110	Commercial Sand Lucern (Switzerland)	22	72.7
25178	Commercial Sand Lucern (Bohemia)	39	64.2
25175	Old German Franconian alfalfa (Bavaria, Germany)	43	56.0
24667	Old German Franconian alfalfa (Bavaria, Germany)	46	54.4
25182	Eifeler lucern (Rhenish, Prussia)	13	54.0
25267	German alfalfa (Prussia)	35	51.5
24733	Old German Franconian alfalfa (Baden, Germany)	43	49.0
25184	Provence alfalfa (Germany)	15	46.6
24602	Provence alfalfa (Germany)	42	40.5
25194	Old German Franconian alfalfa (Bavaria, Germany)	32	40.5
25257	Pfalzer lucern (Baden, Germany)	28	39.4
24923	Old German Franconian alfalfa (Württemberg, Germany)	42	38.0
25269	Roumanian alfalfa (Southern)	36	36.0
24603	Commercial Sand Lucern (Erfurt, Germany)	42	35.8
24635	Old German Franconian alfalfa (Baden, Germany)	41	34.2
24740	Italian alfalfa (northern Italy)	42	33.4
25022	Old German Franconian alfalfa (Baden, Germany)	43	32.6
24721	Provence alfalfa (France)	35	31.5
24767	Old German Franconian alfalfa (Baden, Germany)	42	31.0
25183	Old German Franconian alfalfa (Baden, Germany)	13	30.4
25115	Commercial Sand Lucern (Bromberg, Prussia)	37	29.8
25091	Commercial Sand Lucern (Strasburg, Germany)	41	29.2
24727	German alfalfa (Baden)	44	27.3
24741	Commercial Sand Lucern (Bohemia)	44	27.3
24735	Italian alfalfa	38	26.2
23394	Commercial Sand Lucern (France)	34	26.2
25112	Commercial Sand Lucern (Switzerland).	24	25.0
24718	Moravian alfalfa (Bohemia)	43	23.3
25193	Old German Franconian alfalfa (Baden, Germany)	39	23.0
24728	German alfalfa (Baden)	44	22.7
25111	Commercial Sand Lucern (Switzerland)	22	22.3
24722	Provence alfalfa (France)	45	22.2
25268	Commercial Sand Lucern (Bohemia)	37	21.4
25176	Commercial Sand Lucern (Bohemia)	43	21.0
23481	Commercial Sand Lucern (Hamburg, Germany)	40	20.0
25167	German alfalfa (Thuringia)	41	19.5
25270	Roumanian alfalfa (northern)	36	19.4
24719	Hungarian alfalfa (Austria)	43	18.6
24717	Bohemian alfalfa (Austria)	44	18.3
24730	Russian alfalfa (southern Russia)	46	17.4

[1] At the time of determination of variegation the various rows were indicated by arbitrary numbers. The results were thus not biased by previous knowledge. The variegation was determined by the presence or absence of color change in the standards of the unwithered flowers. This was readily determined in most cases. But in any case, all plants were subjected to a practically uniform judgment.

S P I No	Name and Source	Number of Plants	Per Cent Variegated
25187	Italian alfalfa (Pisa)	36	16 6
24928	Provence alfalfa (Germany)	39	15 3
24723	Russian alfalfa (southern Russia)	46	15 2
24858	Italian alfalfa (Florence)	40	15 0
25181	Pfalzer Lucern (Bavarian Palatinate, Germany)	14	14 3
24732	Russian alfalfa (northern Russia)	46	13 0
24720	Provence alfalfa (Germany)	39	12 8
24729	Hungarian alfalfa (Austria)	44	12 7
23396	Commercial Sand Lucern (Darmstadt, Germany)	35	11 4
24731	Russian alfalfa (southern Russia)	45	11 1
25186	Algerian alfalfa (Setif, Algeria)	19	10 5
25180	Moravian alfalfa (Bohemia)	39	10 3
34724	Russian alfalfa (northern Russia)	41	9 7
24737	Commercial Sand Lucern (Bohemia)	41	9 7
24734	Provence alfalfa (Germany)	42	9 5
25185	Hungarian alfalfa (Austria)	13	7 7
25179	Hungarian alfalfa (Austria)	40	7 5
24725	Spanish alfalfa	33	6 0
25109	Austrian alfalfa (Vienna)	37	5 4
25168	Commercial Sand Lucern (Bohemia)	40	0
24736	Spanish alfalfa	36	0
24726	Turkestan alfalfa	43	0
24738	Turkestan alfalfa	42	0
24739	Turkestan alfalfa	43	0
	Average	37	24 1

Name	Number of Strains	Average Per Cent of Variegation	Average Deviation
Turkestan alfalfa	3	0	0
Spanish alfalfa	2	3	3
Austrian alfalfa	1	5 4	0
Algerian alfalfa	1	10 5	0
Hungarian alfalfa	4	11 6	4 0
Russian alfalfa	5	13 3	2 4
Moravian alfalfa	2	16 8	6 5
Bohemian alfalfa	1	18 3	0
Italian alfalfa	4	22.8	7
Provence alfalfa	7	25 5	12
Palatine (Pfalzer) alfalfa	2	26 8	12 5
Roumanian alfalfa	2	27 7	8 3
Commercial Sand Lucern	15	27 7	12 4
German alfalfa	4	30 2	10 7
Old German Franconian alfalfa	10	38 9	8 9
Eifel alfalfa	1	54 0	0
Combined variegated forms (i e, omitting Turkestans)	61	25 3	

SOCIETIES AND ACADEMIES

THE GEOLOGICAL SOCIETY OF WASHINGTON

At the 234th meeting of the society, held on Wednesday, November 30, 1910, the following papers were read

Regular Program

The Influence of Marine Currents on Deposition in Continental Seas E O Ulrich

This paper tends to prove that Mr. Bailey Willis's views in regard to non deposition in continental seas as the result of current action are in the main unfounded In brief, Mr Willis's views are that the numerous minor hiatuses in the geologic column are commonly to be attributed to non-deposition and even to submarine scour, resulting from marine currents, rather than to emergence of the sea bottom In preface brief allusions were made to instances of local thinning or absence of sediments that may be justly ascribed to current work It is doubtless true that marine currents flow at certain times through sub-marginal troughs like the Lævis channel

Arguments were brought against Willis's views under two headings, namely the improbability of the existence in Paleozoic continental seas of currents competent to bring about such results, and the lack of evidence of such action having taken place under conditions obviously the most favorable for the existence of such currents.

Currents of sufficient intensity to cause an appreciable interruption of deposition over wide interior areas could only exist in great seas, in which the admittedly necessary "trans-continental currents" of Willis might be developed Such seas have no foundation in fact At any given time the Paleozoic seas of North America were far less extensive than those delineated by Willis or even those depicted in Schuchert's "Paleogeography of North America" Such maps are synthetic, giving the maximum development of several successive seas The Black River—early Trenton submergence—having, as generally believed, the greatest areal development of any Paleozoic seas, may be taken as the extreme example. This submergence consisted of no less than five and possibly six distinct transgressions, as shown by the areal distribution of the successive faunas and of the beds containing them. These six faunas are sharply defined and any two juxtaposed faunas show clearly by the varying direction of the overlap of their containing formations that they invaded from quite different oceanic basins Moreover, no two of these faunas

could have been synchronous, since there is no evidence of intermingling of species characterizing the respective formations in the median areas of interfingering overlaps

It is only the pelagic and semi pelagic types that can be depended upon for exact correlation between widely separated areas, and prove the existence of unobstructed current highways Referring to such organisms, the distribution of the Eopaleozoic graptolites offers very strong arguments against the hypothesis of transcontinental currents in the interior basins The most important of the graptolite faunas are confined to current-swept submarginal channels Had these currents continued across the continental border, as assumed by Willis, the graptolites must have been carried by them into and through the interior seas, a condition wholly negatived by the evidence in hand

Perhaps the strongest argument against the efficiency of currents in preventing deposition in the interior continental seas is found in stratigraphic overlaps In any period of sea-advance, beds are deposited by overlap toward the "positive" or relatively elevated areas At the same time, the submergence increasingly favors the formation of currents If currents were present and competent to cause scour, phenomena quite opposed to those observed would obtain The lower beds, which are absent, should be present, and the later beds, formed in a sea supposedly favorable to the extensive development of strong currents, should not be deposited, or should show the effects of current action by diminished thickness

Notes on Argentina BAILEY WILLIS

No abstract

EDSON S BASTIN,
Secretary

THE GEOLOGICAL SOCIETY OF WASHINGTON

AT the 235th meeting of the society, held on December 14, 1910, Mr M R Campbell, the retiring president, presented an address, entitled "Historical Review of Theories Advanced by American Geologists Regarding the Origin and Accumulation of Oil."

At the close of Mr Campbell's address the eighteenth annual meeting of the society was held for the purpose of electing officers, and the following officers were elected for the ensuing year

President—Mr Alfred H, Brooks

Vice-presidents—T W Stanton and David White.

Treasurer—Hoyt S Gale

Secretaries—Edson S Bastin and Robert Anderson

Members at Large of the Council—W C Mendenhall, Wm C Alden, F C Schrader, F B. Van Horn, Adolph Knopf

FRANÇOIS E MATTHES,
Secretary

THE GEOLOGICAL SOCIETY OF WASHINGTON

THE 236th meeting of the society, held on Wednesday evening, December 21, 1910, in the Cosmos Club, was devoted entirely to a discussion of Mr E O Ulrich's paper entitled "The Influence of Marine Currents on Deposition in Continental Seas," delivered before the society on November 30, 1910

The discussion was opened by Mr Bailey Willis, who summed up the propositions from which he wished to dissent as follows (1) that the epicontinental seas of eastern North America during the Middle Ordovician age were so landlocked that marine currents could not have passed through them with sufficient force to have influenced the deposition of sediments, and could not have kept the bottom clean of sediment in any portion of the area which was submerged, (2) that the Gulf Stream does not go to the bottom of its channel and does not scour the bottom The first, which was brought forward by Mr Ulrich, he considered largely theoretical, and founded upon an interpretation of the distribution idea which has not sufficient support in the physical evidence of unconformities that must have been developed by subaerial decay and erosion upon exposed portions

Mr Willis recognized that there are areas characteristic of the shores of the Ordovician sea and of the shores of islands in that sea where unconformities may be recognized by the usual evidences of erosion, and also that there are other localities where limestones are wanting that are elsewhere developed to notable thicknesses In many of these partial sequences there is no evidence of exposure to subaerial agencies In these cases it is reasonable to consider the alternative proposition of marine scour as of at least equal value in interpretation with that of the former existence of land

In answer to Mr Ulrich's statement that the Ordovician seas were landlocked, he pointed out the evidence brought forward by paleontologists for the wide distribution of faunas composed of numerous species, and maintained that marine currents were the most effective agencies in promoting that distribution. Were the seas so land-

locked as Mr Ulrich supposed, the food supply would fail and the condition which has been reached by the present Black Sea whose waters are incapable of supporting life that in any way approaches that of the Ordovician, might be reached

Referring to the paleogeographic maps which have been issued by Dr Schuchert and to Mr Ulrich's views on the details of paleogeography in the Paleozoic age, Mr Willis held that no one is yet in a position to interpret the evidence for limited intervals of time The study requires the most searching investigation of the different lines of evidence and a better understanding of the principles that shall govern the interpretation before any more than general outlines of the geography can be mapped Dr Schuchert's maps represent the distribution of faunas, and for each fauna which is mapped they represent the extent of the temperature, food and other conditions that determined its habitat In this respect they are of the highest value Where, however, the absence of a fauna or a formation has been taken as a proof of the existence of land without evidence of erosion, the maps are misleading, since the alternative hypothesis that the area was submerged, but was inhospitable to that particular fauna, has not received due consideration The causes which now maintain the great equatorial currents flowing from east to west have been in operation since the oceans were established Currents and eddies diverted from these main currents by the continental platforms have necessarily been features of all continental seas, and no study of the life conditions of extinct faunas can be adequate that does not take account of the biological and physical effects of such currents Hence any inference based upon faunas which are interpreted without reference to currents must be fallacious

In regard to the subject of marine scour, especially by the Gulf Stream, Mr Willis presented a map showing the submarine deposits of the Caribbean, Gulf and North Atlantic, as given by Agassiz in the "Three Cruises of the *Blake*" That map shows that sediment is deposited under the axis of the Gulf Stream between Cuba and Florida along much of the coast, for the depth of the water is there greater than the depth of the current, which does not reach much below 100 or 150 fathoms, but where the water is shallower or where the current turns from its easterly to a northerly course, it is carried against the bottom and at those points there is a hard limestone bottom covered only by fragments of broken rock and coral, and washed clean by the current. It also appeared from Agassiz's discussion of the action of the dredge that the areas which he mapped as limestone plateaus have a hard and uneven rock bottom, and although the Coast Survey charts over much of the areas so mapped by him show soundings of sand and broken shell, the evidence is that the material brought up on the sounding line is but a superficial coating, hardly covering the uneven limestone bottom Admiral Pillsbury has shown that the volume of water passing a section of the Florida Straits in one hour amounts to nearly 90 billion tons It has a velocity which varies from two to three and one half knots The energy of this mass of water could not be lightly checked Should the sea bottom between Florida and Cuba be gently elevated by an orogenic movement, or should the general level of the ocean be lowered so that the current would reach the bottom, the silt which is now deposited beneath the current would inevitably be swept away A barrier to the current would only be established in case the orogenic movement raised the bottom more actively than the current could erode it This could scarcely occur unless the bottom were hard rock The condition which is thus suggested is that which may be considered as a working hypothesis in explanation of the imbricated limestone of the Ordovician in the eastern United States. It is postulated that there was an extensive sea which was open from south to north, and through which marine currents circulated, as is indicated by the distribution of life The sea deepened or shallowed from time to time, and there were basins which, according to the great thickness of sediments laid down in them, deepened, while other areas apparently remained as saddles between them. If this interpretation of the physical and faunal facts be correct, it is reasonable to suppose that the currents were at times brought within reach of the bottom and that a condition of non-deposition supervened locally during a more or less prolonged interval

The discussion was continued by Rear Admiral J. E Pillsbury, who had command of the Coast Survey steamer *Blake* for five years and spent a large portion of each year investigating the Gulf Stream He first explained the methods formerly used of gauging marine currents by cans floating on the surface and submerged below, and then the methods adopted by the *Blake* of anchoring the vessel in the stream and measuring the

velocity and direction of the flow on the surface and at various depths by means of a current meter Many hundreds of observations were taken in the straits of Florida between Fowey Rocks and the Bahamas, between Havana and the Florida reefs, in the Straits of Yucatan, in the Equatorial Current between Tobago and Barbadoes, in all the passages between the West Indian Islands and off Cape Hatteras

The section off Fowey Rocks was studied during two winter seasons and at other times for brief periods This is the narrowest part of the Straits of Florida, being about 42 miles in width On the west side the bottom descends with fairly regular slope to 400 fathoms, at 15 miles distant, while on the east side 400 fathoms is found at but eight miles from the shore Anchorages were made at approximately seven-mile intervals across the straits The bottom was found to be branch coral and broken shells at the anchorage nearest the Bahamas, and there was every evidence from the observations that the current reached the bottom here The stream off Havana flows east, while off Fowey Rocks it has changed its direction 80°, and the inertia of the water in making the turn forces the current to impinge upon the confining bank and carries it to the bottom Between this point and the western slope the observations showed an average current only to about 300 fathoms depth, while on the western slope itself the current sometimes reached the bottom and sometimes a negative current was observed At all anchorages except the easternmost, mud was brought up by dredge and frequently on the anchor. At eleven and one half miles east of Fowey Rocks there is an outcropping of rock on which an anchor fouled three times, making it necessary to cut the anchoring rope to get underway, but at other places the bottom was soft On both sides of the straits the current at times was found to be flowing north as far out as a depth of 10 fathoms or even further off shore

It has been stated that the presence of gulf seaweeds near Nantucket shows the Gulf Stream to be flowing there The Gulf Stream is partly caused by the friction of the trade-winds on the surface of the ocean, and partly by the break of the wave which throws a certain amount of water from its crest into the trough As the trades are persistent, this becomes a simultaneous movement of the whole surface of the sea within trade-wind limits. Gulf seaweed floats with the current, but it is thrown to leeward by the waves faster than any ordinary current can carry it, or when there is no current at all The water on the Florida reefs about Key West are of milky appearance, while a northerly breeze is blowing which stirs up the bottom coral mud A southerly breeze brings in the clear water of the Gulf Stream simply by the break of the waves, but no current accompanies it

The Grenadine Bank extends from Grenada to the Island of St Vincent and is in the direct line of flow of the trade wind current outside the Caribbean An anchorage in 17 fathoms near its outside edge showed no current crossing the bank, but the break of the waves was all the time carrying water into the Caribbean across the shoal

As the discussion was extended to a consideration of the general effects of oceanic currents on deposition, Mr T Wayland Vaughan called attention to the investigations Rear Admiral Sir W J L Wharton[1] made around the islands of the Ellice Group and on submarine banks in that region According to this authority, fine mud and sand may be moved to a depth of 80 fathoms, and there is evidence of the chafing of cables to a depth of 260 fathoms, "volcanic ash can be moved at depths of 30 fathoms or more when exposed to the action of waves in an otherwise deep sea over which strong winds are continually blowing"

Professor J Stanley Gardiner[2] has described the submarine platform on which the Maldive and Laccadive archipelagoes stand, and has called attention to the generally hard bottom on it This platform occupies a level about 200 fathoms below sea level, and he says, "there is little doubt but that it is surrounded with precipitous walls or a steep slope for an additional 600 fathoms at least" Professor Gardiner is of the opinion that this platform was formed by marine erosion to the depth of 200 fathoms below sea level. He states, "there is little doubt but that currents may extend to considerable depth and sweep the ocean floor quite bare. Indeed, wherever in the ocean a rocky bottom is found, its character is probably due to an ocean current"

Dr Paul Bartsch discussed the distribution of the recent marine mollusks with a view to throwing some light upon past conditions He presented a map showing the extent of the existing faunal areas and called special attention to the

[1] *Nature*, LV, 1897, "Foundations of Coral Atolls"

[2] "The Fauna and Geography of the Maldive and Laccadive Archipelagoes," Vol 1, Pt. 2, pp 172, 173.

fact that these areas are coextensive with the existing ocean currents

He gave some tables, based upon the West American Pyramidellidæ, showing that in this group a remarkably small percentage of the species extended over more than one area He stated that he considered ocean currents an important factor in the distribution of marine organisms, since they determined practically all the factors entering into the environment in each area, viz, temperature, food, salinity and transportation of larval forms

Mr Ulrich, replying to Mr Willis's discussion, said that most of Mr Willis's objections had been anticipated and accounted for in the paper read at the previous meeting It was denied that this paper contained any statement indicating that its author is inclined to the belief that marine currents in the Ordovician epicontinental seas of North America were *never* capable of effecting the deposition of sediments or of keeping the "bottom clean of sediment in any portion of the submerged seas" On the contrary, Mr Ulrich mentioned a number of instances of locally interrupted deposition attributable to current scour but claimed that these were quite distinct in their causation from the wider discontinuities which have been similarly interpreted by Mr Willis It was further denied that the paper sought in any wise to discredit the effect of currents on the distribution of marine organisms Also that the deduction of frequently shifting, limited and far from transcontinental seas is founded solely on "an interpretation of the distribution of faunas which disregards all the limiting conditions of marine environment except land barriers" Mr Ulrich insisted that before reaching his conclusions he had considered more or less fully all physical as well as the purely faunal criteria that seemed to have any direct bearing on the problem Considering that Mr Willis has paid perhaps as little attention to detailed field investigation of stratigraphic unconformities as to the study of recent or fossil zoology, his short dismissal of conclusions based largely upon such studies as "purely theoretical" seems rather unscientific His remark respecting detailed paleogeographic mapping, when he said "that no one is yet in a position to interpret the evidence for limited intervals of time" is similarly unjust

Mr Willis's statement that the Ordovician seas, "if so land locked as Mr Ulrich supposed," would have become, like the Black Sea, "incapable of supporting life that in any way approaches that of the Ordovician," was based upon a misconception of Mr. Ulrich's meaning As conceived by Mr Ulrich, Ordovician continental seas invaded the land areas from one or another of the permanent oceanic basins, with which they maintained their connection and from which they derived their faunas throughout their existence

Evidence of erosion is nearly always to be found wherever a considerable hiatus in the stratigraphic sequence is indicated by the fossils. In view of the fact that such breaks in the stratigraphic sequence commonly extend over by far the greater part of the median area of the continent, it is impossible to account for the wide absence of the deposits and faunas by virtue of any reasonably conceivable current efficiency Nor can any other interpretation save emergence be advanced to explain the established geographic limitations of the Paleozoic faunas, especially when no fauna of nearly similar age is found in adjacent areas

The distribution of many types of littoral and bottom-dwelling organisms takes place largely in disregard of marine currents There are other types, however, notably the plankton and especially reef corals and sessile bryozoa, which propagate by means of free-swimming larvæ, that throw much light on the direction and extent of the currents in the Paleozoic continental seas In every case where the distribution of the latter has been studied it is found that they rapidly become fewer away from the point of invasion of the particular sea in which they lived In most instances they disappear entirely before reaching the inner shores of the sea whose extent is determined by continuity of deposits and the presence of other organisms less dependent on currents for their migration This perfectly competent evidence, therefore, is invariably opposed to Mr Willis's theory of great inland seas and of transcontinental currents which if present might have been important factors in accounting for stratigraphic hiatuses

Dr R. S Bassler called attention to the fact that the trend of the discussion was losing sight of the stratigraphic side of the question These distinct northern and southern faunas occurred in distinct formations overlapping to extinction either to the south or north as the case might be. He added that these facts must be explained before currents can be held accountable for the great faunal differences

EDSON S BASTIN,
Secretary

SCIENCE

FRIDAY, MARCH 3, 1911

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MSS. intended for publication and books, etc., intended for review should be sent to the Editor of SCIENCE, Garrison-on-Hudson, N. Y.

UNIVERSITY REGISTRATION STATISTICS

THE registration returns for November 1, 1910, of twenty-seven of the leading universities of the country will be found tabulated on the following page Four institutions exhibit a decrease in the grand total enrollment this year, viz, Harvard, Iowa, Indiana and Virginia, as against four institutions in 1909, two in 1908 and five in 1907 The largest gains in terms of student units, including the summer session attendance, but deducting summer students who returned for work in the fall, were registered by Columbia (with an unprecedented increase of 1,279 students), California (674), Minnesota (621), Wisconsin (500), Chicago (396), Northwestern (346) and Pennsylvania (330). Last year there were also seven institutions that showed a gain of over three hundred students each, but only one (Columbia) that registered an increase of over four hundred students Omitting the summer session attendance, the largest gains have been made by Columbia (796), Minnesota (621), California (496), Wisconsin (407), Northwestern (379), Nebraska (236) and Chicago (231), seven universities exhibiting an increase of over two hundred students in the fall attendance, as against eleven last year, and it will also be observed that only one of the seven is an eastern institution, whereas the eleven last year were fairly evenly divided between the east and the west

According to the figures for 1909, the twenty-eight universities included in the table ranked as follows: Columbia, Harvard, Chicago, Michigan, Cornell, Pennsylvania, Illinois, Minnesota, Wisconsin,

Faculties, November 1, 1910	California	Chicago	Columbia	Cornell	Harvard (incl Radcliffe)	Illinois	Indiana	Iowa	Johns Hopkins	Kansas
College Men	694	761	729	722	2206	397	541	482	190	539
College Women	1080	688	521	261	487	475	373	486		536
Scientific Schools*	780		718	1576	121	1067		176		404
Law	189	192	365	267	794	146	139	204		210
Medicine	91	141	316	159	279	514	186	134	395	89
Non Professional Grad Sch	371	445	1167	288	456	289	139	101	200	66
Agriculture	220			760	†	629				
Architecture	†		156	133	†	273				
Art	236				†	4		†		39
Commerce	241				73	137		†		
Dentistry	59				117	140		142		
Divinity		167			53					
Forestry	†				†	†				
Journalism						26				
Music	†		21			53		45		134
Pedagogy	†	228	1406			†		†		†
Pharmacy	85		283			160		40		68
Veterinary Medicine				104						
Other Courses		573		871		39		47		
Deduct Double Registration	*96*	*160*	*230*	*8*			*79*	*103*	*1*	*59*
Total	3950	3035	5446	4562	4583	4829	1299	1754	784	2028
Summer Session 1910	1051	3370	2632	987	873	665	1137	345		390
Deduct Double Registration	*243*	*522*	*667*	*400*	*133*	*335*	*304*	*143*		*164*
Grand Total 1910	4758	5833	7411	5169	5339	4659	2132	1957	784	2246
" " 1909	4084	5487	6132	5028	5558	4502	2231	2246	710	2144
" " 1908	3751	5114	5675	4700	5342	4400	2113	2256	698	2086
" " 1907	3346	4594	5197	4293	5346	4172	1667	2188	651	1982
" " 1906	3246	4731	4650	4075	5343	3810	1515	1950	618	1690
" " 1905	3631	4557	4755	3871	5283	3635	1377	1700	488	1706
" " 1904	3738	4635	4833	3833	5392	3369	1206	1460	740	1446
" " 1903	3090	4146	4557	3438	6013	3239	1614	1260	694	1319
Extension and Similar Courses	302	2800	1636	‡	7				98	80
Officers	349	334	761	650	618	582	100	175	198	148

Faculties, November 1, 1910	Michigan	Minnesota	Missouri	Nebraska	New York	Northwestern	Ohio State	Pennsylvania	Princeton	Stanford
College Men	1257	705	517		352	418	400	434	1118	{ 836
College Women	638	930	448		171	548	346			
Scientific Schools*	1243	562	544		206	54	790	803	203	490
Law	740	367	212		725	240	166	345		118
Medicine	318	169	47		495	477		458		17
Non Professional Grad Sch	135	54	99		291	78	65	397	130	125
Agriculture		1221	342				411			
Architecture	†	11					49	199		
Art										
Commerce	†			‡	1079	547		844		
Dentistry	239	208				376		453		
Divinity						207				
Forestry	†	112					58			
Journalism	†		91							
Music						285		25		
Pedagogy	†	55	161		345		59			47
Pharmacy	81	90				194	87			
Veterinary Medicine					15		181	167		
Other Courses		183				185	191	534		
Deduct Double Registration			*192*		*109*	*51*	*20*	*40*		
Total	4651	4657	2269	3357	3570	3508	2808	4614	1451	1633
Summer Session 1910	1226	457	597	444	529	75	637	689		56
Deduct Double Registration	*538*	*142*	*188*	*140*	*152*	*40*	*259*	*116*		*41*
Grand Total 1910	5339	4972	2678	3661	3947	3543	3181	5187	1451	1648
" " 1909	5259	4351	2589	3402	3843	3197	3012	4857	1396	1620
" " 1908	5188	4607	2558	3154	3951	3113	2700	4555	1314	1541
" " 1907	4953	4297	2274	2812	3645	2714	2344	4134	1311	1594
" " 1906	4674	3944	2071	2807	3283	2635	2180	3934	1352	1530
" " 1905	4521	3940	1887	2635	2912	2791	2057	3430	1361	1606
" " 1904	4000	3888	1704	2728	2580	2856	1758	3027	1385	1424
" " 1903	3926	3550	1540	2518	2177	2740	1710	2644	1434	1370
Extension and Similar Courses		65			750	142				
Officers	401	324	204		843	440	233	485	177	292

Faculties, November 1, 1910	Syracuse	Texas	Tulane	Virginia	Western Reserve	Wisconsin	Yale
College Men	{ 1380	581	107	338	405	918	1226
College Women		489	140		303	785	
Scientific Schools*	355	254	143	90		829	1024
Law	197	281	77	178	168	149	282
Medicine	108	167	439	78	166	48	82
Non Professional Grad Sch	70		87	29	13	285	423
Agriculture						564	
Architecture	56		18				
Art	148		126				46
Commerce						310	
Dentistry			67		88		
Divinity							95
Forestry							85
Journalism						†	
Music	764		61			70	80
Pedagogy	94	†	64				
Pharmacy		51	14		93	47	
Veterinary Medicine							
Other Courses	99	32	44		66	29	
Deduct Double Registration	*71*		*104*	*25*	*28*	*73*	*65*
Total	3150	1835	1238	688	1274	3902	3287
Summer Session 1910	189	839	966		—	1263	
Deduct Double Registration	*91*	*77*	*219*		—	*420*	
Grand Total 1910	3248	2597	1985	688	1274	4745	3287
" " 1909	3248	2492	1852	767	1083	4245	3276
" " 1908	3204	1446	1171	757	1016	3876	3468
" " 1907	3162	1474	1219	757	914	3401	3435
" " 1906	3004	1351	1285	745	905	3099	3477
" " 1905	2778	1190	838	696	856	3068	3477
" " 1904	2452	930	1124	691	806	3570	3008
" " 1903	2207	785	1037	688	765	3221	2990
Extension and Similar Courses		332	48		116	605	
Officers	250	116	216	97	256	436	499

* Includes schools of mines, engineering, chemistry and related subjects.
† Included elsewhere.
‡ No figures furnished.
Note.—The Texas and Tulane figures for 1903–1906 are exclusive of the summer session.

California, New York University, Nebraska, Yale, Syracuse, Northwestern, Ohio State, Missouri, Texas, Iowa, Indiana, Kansas, Tulane, Stanford, Princeton, Western Reserve, Washington, Virginia, Johns Hopkins. Comparing this with the order for 1910, we note that Chicago and Michigan have passed Harvard, that Pennsylvania has changed places with Cornell, that Illinois has been passed by Minnesota, California and Wisconsin, that California and Wisconsin have changed places, that Northwestern has passed Yale and Syracuse, that Kansas has outstripped Iowa and Indiana, as Tulane and Indiana have Iowa, and, finally, that Johns Hopkins and Virginia have changed places. For the first time in the annals of American universities the seven thousand mark has been passed, Columbia having a grand total registration this year of 7,411 students, a figure that will closely approach the eight-thousand mark before the end of the academic year. Pennsylvania is the sixth institution to pass the five-thousand mark, Cornell passed it in 1909, Chicago and Michigan in 1908, Columbia in 1907 and Harvard somewhat earlier. If the summer session enrollment be omitted, the universities in the table rank in size as follows: Columbia, Minnesota, Michigan, Pennsylvania, Harvard, Cornell, Illinois, California, Wisconsin, New York, Northwestern, Nebraska, Yale, Syracuse, Chicago, Ohio State, Missouri, Kansas, Texas, Iowa, Stanford, Princeton, Indiana, Western Reserve, Tulane, Johns Hopkins, Virginia, this order also showing a number of changes as compared with 1909, notably the advancement of Minnesota from seventh to second place.

Examining the various faculties in order, we find that the usual gains in the male undergraduate academic departments continue, the total increase being one of approximately a thousand students, it is impossible to calculate the increase with absolute accuracy, owing to constant changes of classification. On the other hand, it is noteworthy that the number of undergraduate women shows a decrease at the majority of the institutions in the list—quite an unusual condition. Harvard continues to lead in the number of male academic students, being followed by Michigan, Yale, Princeton, Wisconsin, Chicago, Columbia, Cornell, Minnesota, including the women, the order is Harvard, Michigan, California, Wisconsin, Minnesota, Chicago, Syracuse, Columbia, Yale, Princeton, Texas and Kansas, each of these institutions enrolling over one thousand academic students.

The number of scientific students is considerably smaller than it was last year, more than half of the institutions showing a loss compared with 1909. The chief gains were made by Illinois, Yale and Columbia, in the order given. The institutions that attract over five hundred students to their engineering schools are Cornell, which continues to maintain its old lead in this field, Michigan, Illinois, Yale, Wisconsin, Pennsylvania, Ohio State, California, Columbia, Minnesota, Missouri and Nebraska, in the order named, the first four universities mentioned enrolling over one thousand students each.

As was the case last year, there has been a decrease in the number both of medical and law students, this being due in the majority of the instances to a raising of the requirements for entrance to these professional schools. The largest gains in medicine have been registered by Western Reserve, California and Johns Hopkins, in law by Stanford, Columbia and Harvard, the largest losses in the former have been experienced by Northwestern, Pennsylvania and Iowa, in the latter by Virginia,

Yale and Texas Illinois now attracts the largest number of medical students, followed by New York University, Northwestern, Pennsylvania, Tulane, Johns Hopkins, Michigan and Columbia, each of these institutions enrolling more than three hundred students In law, Harvard and Michigan have passed New York University, these being followed by Minnesota, Columbia and Pennsylvania, the six institutions mentioned being the only ones in the table to attract over three hundred students.

Sixty per cent. of the graduate schools show an increase over last year's enrollment, and where losses are registered, they are slight Columbia, Stanford and Illinois exhibit the largest gains, the first named institution, with an enrollment of 1,167 non-professional graduate students, having more than twice as many as the next largest, Harvard (456), which is followed in turn by Chicago, Yale, Pennsylvania, California, New York, Cornell, Illinois and Wisconsin, each of these institutions enrolling more than two hundred students Over two thirds of the students enrolled in these eleven universities are to be found in eastern institutions

All of the schools of agriculture continue to show a highly encouraging increase, Minnesota remaining at the head of the list, while Cornell has passed Illinois — Of the architectural schools Cornell and Syracuse show slight losses, the others having registered an increase, especially Illinois and Columbia The four largest schools are Illinois, Pennsylvania, Columbia and Cornell, in the order named, the two latter having changed places since the last year —The largest schools of commerce are those of New York University, Pennsylvania and Northwestern, and all of these show very considerable gains in attendance over last year Wisconsin and California have also increased their enrollment in this field, while Illinois and the Harvard graduate school of business administration have remained stationary With the exception of Iowa and Tulane, all of the dental schools have increased their attendance, Northwestern, Illinois and Harvard showing the largest gains The institutions continue to rank in the order Pennsylvania, Northwestern, Michigan, Minnesota, in this department —Of the four divinity schools, Harvard alone shows a gain, the order in point of size being Northwestern, Chicago, Yale, Harvard — At all of the institutions where the students of forestry are listed separately, a gain is apparent —In the department of music, half of the institutions show a decrease in the number of students, this being especially large in the case of Northwestern and Wisconsin Syracuse, Nebraska and Northwestern continue to have the largest schools —In the department of pedagogy Minnesota, Missouri and New York University have suffered losses in attendance, while the other universities registered gains, especially the Teachers College of Columbia University, which exhibits an increase of no less than 432 students, it being by far the largest school of education in the country It is followed by New York University, Chicago and Missouri, in the order named —There has been a slight gain in the total number of students of pharmacy, the largest decrease having been experienced by Northwestern, the largest increase by Western Reserve, the other institutions being about evenly divided in the matter of gains and losses The three largest schools continue to be Columbia, Northwestern and Illinois —Ohio State, which has the largest school of veterinary medicine, has registered a loss of 21 students, Pennsylvania, which comes next, has

remained stationary, and Cornell and New York University have made slight gains

The summer sessions are enjoying continued prosperity, especially noteworthy gains having been experienced by Columbia (664), Pennsylvania (240), California (232) and Tulane (184), while Harvard registered a decrease of 504 students The only other decrease of moment was experienced by Northwestern, where the summer session in medicine has been abandoned, Iowa, New York University, Syracuse and Texas show slight losses, while Indiana, Michigan, Minnesota, Ohio and Stanford have remained practically stationary Chicago continues to assemble the greatest number of summer students in its summer quarter, Columbia's summer session is rapidly nearing the three-thousand mark, while Wisconsin, Michigan, Indiana and California have over a thousand students each Then come Cornell, Tulane, Harvard, Pennsylvania and Illinois, in the order named

Of the New England colleges for men included in the following table, Dartmouth, Tufts, Wesleyan and Williams show gains over last year, Amherst and Bowdoin losses Brown also shows a loss, as do Bryn Mawr and Mt Holyoke, while Smith, Vassar and Wellesley have more students than last year Massachusetts Institute of Technology, Lafayette and Oberlin have gained, Haverford, Lehigh and Purdue lost —At Amherst the introduction of a group system of electives, as well as the inauguration of a one-half-year rule in public exhibitions, may have had some effect on the diminution in size of the entering class —At Brown 657 of the college students are men, 199 women, and there are 74 graduate students enrolled.—At Bryn Mawr there are 69 graduate students. During the year 1909–10 this college received gifts amounting to $694,000.

Institution	1910	1909	1908	1904
Amherst	502	526	528	412
Bowdoin (incl med)	398	419	420	363
Brown (incl graduate school)	930	974	993	988
Bryn Mawr (incl graduate school)	409	412	393	441
Dartmouth (incl eng, med, grad stud and commerce)	1,229	1,197	1,233	926
Haverford	150	137	160	146
Lafayette	496	468	455	422
Lehigh	616	667	662	609
Massachusetts Institute of Technology	1 506	1,480	1,462	1,561
Mount Holyoke	743	752	748	674
Oberlin (college of arts and sciences only)	998	953	855	652
Purdue	1 611	1,682	1,717	1,359
Smith	1,618	1,609	1,500	1,067
Tufts (college and engineering)	433	428	434	375
Vassar	1,058	1,039	1,014	979
Wellesley	1,378	1,319	1,282	1,050
Wesleyan	365	343	322	305
Williams	541	528	487	443

—At Dartmouth 1,144 students are registered in the college, 43 in the engineering school, 41 in medicine, 34 in the Tuck school of commerce and administration, and 21 are graduate students There were also 151 students enrolled in the summer school of this institution, of whom 47 returned in the fall, giving a grand total of 1,333 students Dartmouth has just completed a new gymnasium building, while an administration building is being erected for the college offices only —Haverford College is completing a new science hall, principally for chemistry, and has received a donation from an alumnus for a building for the Haverford Union The college has also introduced a pension system, for which a fund of $150,000 has been raised —At Lafayette College 77 students are enrolled in the classical course, 135 in the Latin scientific, 45 in the general scientific, 47 in the chemical, 89 in the civil engineer-

ing, 55 in the electrical engineering, 34 in the mining engineering and 14 in the mechanical engineering course.—Lehigh University has 540 engineering students, 48 in the college, and 28 graduate students. The physical equipment of the university has been materially strengthened by the erection of two new laboratories—the Fritz engineering laboratory and the Eckley B. Coxe mining laboratory, the former is devoted to tests in strength of materials, cement and concrete, hydraulics and road materials, the latter to experimental ore-dressing. Both laboratories are equipped with the most modern machinery and apparatus. Four new four-year plans of study leading to the degree of bachelor of science are offered by the university in the department of arts and science, *viz.*, one in which the biological and chemical sciences predominate, one in which the geological sciences predominate, one in which the mathematical and physical sciences predominate, and one in business administration.—At the Massachusetts Institute of Technology German has been made a required subject for all first-year students with the exception of the architects, who are required to take French; previously all first-year students could choose between German and French. Of the 1,506 students enrolled at the institute this winter, 107 are in the school of architecture. There were also 239 students in attendance on the 1910 summer session, of whom 175 returned in the fall, giving a total enrollment for the year of 1,570.—At Mount Holyoke College a dormitory, accommodating about twenty-five persons, has been added during the summer.—The total fall registration of Oberlin College is 1,826, divided as follows: college of arts and sciences 998, theological seminary 65, conservatory of music 406, academy (preparatory) 315, drawing and painting (college and preparatory) 42.—The students at Purdue University are distributed as follows: school of science 162, chemical engineering 80, civil engineering 334, electrical engineering 390, mechanical engineering 306, graduate students 30, agriculture 262, and pharmacy 74. The entrance requirements for the school of pharmacy have been raised to correspond to those of all the other departments of the university, namely, four years of preparation in a standard high school, the increase in requirements having led to a twenty five per cent. decrease in enrollment. An increase of no less than forty per cent. was registered in the freshman class of the school of agriculture. There has also been an appreciable increase in the number of women students, due to growth in the department of household economics. A notable addition to the resources of the university consists of the erection of a new group of buildings for the department of shop practise and drawing, comprising some 70,000 square feet of floor space with modern equipment.—At Smith College it is the object of the authorities at present to keep the enrollment as near 1,600 as possible, this being done by limiting the size of the entering class.—The total enrollment of Tufts College consists of 1,141 students, divided as follows: college, 111 men and 84 women, engineering schools 238, medicine 388, graduate students 7, dentistry 303, and divinity 10.—At Wellesley College there are 1,290 regular undergraduate students, 57 special students and 31 graduate students. Two new buildings have been added to the equipment, namely, a library and a gymnasium (Mary Hemenway Hall).—Of the 365 students at Wesleyan, 9 are women and 7 are graduate students.—At Williams 9 of the students are candidates for the degree of master of arts. A new infirmary and a

new auditorium are in process of construction and a new dormitory will be commenced soon This is the first year in which no "partial course" freshmen have been admitted, all those that entered being candidates for the degree of bachelor of arts[1]

RUDOLF TOMBO, JR

COLUMBIA UNIVERSITY

SUMMARY OF THE FIFTH ANNUAL REPORT OF THE CARNEGIE FOUNDATION[1]

THE fifth Annual Report of the President of the Carnegie Foundation covers the year ending September 30, 1910 The report is divided into two parts Part I pertains to the current business of the year, Part II is a discussion of the Relation of the College and the Secondary School

The report shows that the trustees had in hand at the end of the year funds amounting to $11,114,056 86, consisting of the original gift of $10,000,000 par value of five per cent bonds and one million accumulated surplus The income for the year was $543,881 20 During the year 64 retiring allowances were granted, of which 46 were in accepted institutions and 18 in institutions not on the accepted list During the year 23 pensioners died

Among distinguished teachers who retired during the year were Professor Burt G Wilder, of Cornell, Dean Van Amringe and Professor Chandler, of Columbia, both well advanced in years and in academic honors, Professor George L. Goodale, the famous botanist of Harvard, Professor Osborne, of the Massachusetts Institute of Technology, who has taught mathematics in that institution since its foundation, Chancellor MacCracken, of New York University, President Seelye, of Smith College, and Professor Calvin M. Woodward, of Washington University, St Louis These distinguished men average in age seventy-two years, and illustrate how well the vigor and influence of the scholar can be continued to a ripe maturity

There were admitted to the accepted list during the year the University of California, the joint institutions of the State of Indiana —Indiana University and Purdue University —and Wesleyan University, the last named a college

In the first part of the report the president of the foundation follows up the bulletin on medical education by a paper on the relation of the university to the medical school, in which he calls attention to the responsibility attaching to any college or university which undertakes medical education

The second part of the report is a careful attempt to state the existing causes of friction between the secondary school and the college, and the loss of educational efficiency in the present methods of bringing pupils from the school to the college The complaint of the college against the secondary school and the complaint of the secondary school against the college are set forth

An extremely interesting part of the report is a statement of the observations of Oxford tutors upon the preparation of the Rhodes scholars The strong points in the American boy's preparation are readily seen by these trained teachers, and the weaknesses which they find point directly to the superficiality and diffusion of the work done in the American secondary school and college

The president of the foundation urges that this whole question be approached by secondary school men and college men in a spirit of cooperation Neither the certificate method of admission nor the piecemeal examination method have, in his opinion, solved the problem He urges that the college must find a solution which will test better than the certificate or the piecemeal examination the fundamental qualities of the student, and which will at the same time leave to the high school a larger measure of freedom. He recommends a combination of certificate and examinations, the latter of simple and elementary character, but calling for a high quality of performance

[1] An abstract of this article appeared in the *Evening Post* (New York) of February 11

[1] Press bulletin supplied by the foundation

without which the candidate will not be admitted. For example, under this plan the boy who can not write good idiomatic English would not be admitted to college at all, but would be sent back to the secondary school. The entrance requirements recently adopted at Harvard are quite in line with these recommendations. The president of the foundation urges a cooperation between the secondary school and the college not as unrelated institutions, but as two parts of a common system of education. He argues that the interest of the great mass of high school students must not be sacrificed to the interest of the minority who are looking toward college. He insists on a larger measure of freedom for the secondary school, but on the other hand, he argues that the interest of the boy who goes to college and the boy who goes from the high school into business are alike conserved by learning a few things well, not by learning many things superficially. The boy who has obtained such intellectual discipline is a fit candidate for college, whether he has studied one set of subjects or another; without this intellectual discipline he is unfit alike for college or business. It is therefore, in the opinion of the president of the foundation, the plain duty of the college, at the present stage of American educational development, to articulate squarely with the four-year high school and to leave the secondary school the largest freedom so that it may educate boys, not coach them, but at the same time to require of the candidates for admission tests which rest upon high performance in the elementary studies and which mean mastery of the fundamentals. In such a program lies the hope of scholarly betterment and of civic efficiency for both college and high school.

The report may be obtained by writing to The Carnegie Foundation, 576 Fifth Avenue, New York City.

THE PUBLIC HEALTH SERVICE

The following bill has been introduced in the senate and in the house of representatives:

A Bill To change the name of the Public Health and Marine Hospital Service to the Public Health Service, to increase the pay of officers of said service, and for other purposes.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That the Public Health and Marine-Hospital Service of the United States shall hereafter be known and designated as the Public Health Service, and all laws pertaining to the Public Health and Marine-Hospital Service of the United States shall hereafter apply to the Public Health Service, and all regulations now in force, made in accordance with law for the Public Health and Marine Hospital Service of the United States shall apply to and remain in force as regulations of and for the Public Health Service until changed or rescinded. The Public Health Service may study and investigate the diseases of man and conditions influencing the propagation and spread thereof, including sanitation and sewage and the pollution either directly or indirectly of the navigable streams and lakes of the United States, and it shall from time to time issue information in the form of bulletins and otherwise for the use of the public.

Sec. 2. That beginning with the first day of July next after the passage of this act the salaries of the commissioned medical officers of the Public Health Service shall be at the following rates per annum: surgeon general, $6,000; assistant surgeon-general, $4,000; senior surgeon, of which there shall be ten in number, on active duty, $3,500; surgeon, $3,000; passed assistant surgeon, $2,400; assistant surgeon, $2,000; and the said officers, excepting the surgeon general, shall receive an additional compensation of 10 per cent. of the annual salary as above set forth for each five years' service, but not to exceed in all 40 per cent.: Provided, That the total salary, including the longevity increase, shall not exceed the following rates: assistant surgeon general, $5,000; senior surgeon, $4,500; surgeon, $4,000: Provided further, That there may be employed in the Public Health Service such help as may be provided for from time to time by Congress.

SCIENTIFIC NOTES AND NEWS

At a meeting held on January 12 the Geological Society in Stockholm, Sweden, elected to eight vacancies in their twenty corresponding memberships, Frank D. Adams, Montreal; Charles Barrois, Lille; Eduard Bruckner, Vienna; Albrecht Heim, Zurich; C. R. van Hise, Madison; James F. Kemp, New

York, Albrecht Penck, Berlin, and Charles D Walcott, Washington

DR W J. HOLLAND, director of the Carnegie Institute, Pittsburgh, has received from the Czar of Russia, the insignia of a knight of the order of St Stanislas, second class, in recognition of his services to science, and Mr A S Coggeshall, the chief preparator in the section of paleontology in the same institution, has had conferred upon him by the same sovereign knighthood in the order of St Anne

DR HENRY PRENTISS ARMSBY, director of the Institute of Animal Nutrition of the Pennsylvania State College, has been elected a member of the Royal Society of Arts of Great Britain.

DR H. LORENZ, professor of physics at Leyden, and Dr E Strasburger, professor of botany at Bonn, have been elected members of the St Petersburg Academy of Sciences

DR HENRY FAIRFIELD OSBORN, president of the American Museum of Natural History and Da Costa professor of zoology at Columbia University, was given a dinner by his former students at the Faculty Club of Columbia University, on February 18, in celebration of his thirtieth anniversary as a teacher About forty-five guests and former students under Professor Osborn at Columbia and Princeton Universities were present Speeches were made by Professors E B Wilson, W B Scott and C F W McClure

DR. HENRY M HURD has retired from the superintendency of the Johns Hopkins Hospital, and is succeeded by Dr W H Smith, superintendent of Bellevue Hospital, New York City

DR ANDREW W PHILLIPS, since 1891 professor of mathematics in Yale College and since 1895 dean of the graduate school, will retire from active service at the close of the present academic year.

CHARLES JOYCE WHITE, professor of mathematics at Harvard University from 1885 to 1894, has been appointed emeritus professor, and William Barker Hills, associate professor of chemistry from 1889 to 1904, has been appointed emeritus associate professor

THE University of La Plata and the University of Michigan have arranged for cooperation in the work of their astronomical observatories Professor W J. Hussey has been appointed director of La Plata Observatory, but is still to remain director of the observatory of the University of Michigan He will divide his time equally between the two institutions, spending the second semester of each year at Ann Arbor Mr R P Lamont, of Chicago, is furnishing a 24-inch refracting telescope for the University of Michigan It is the intention to take this instrument, when completed, to a favorable site in Argentina, and while it is there to have it used under the joint auspices of the two universities

PROFESSOR GILBERT N LEWIS, of the Massachusetts Institute of Technology, will deliver eight lectures on "The Principle of Relativity," on Monday and Thursday afternoons, beginning on March 6, in the Jefferson Physical Laboratory of Harvard University

UNIVERSITY AND EDUCATIONAL NEWS

IN the Massachusetts senate on February 21 the committee on education reported a resolve, on the petition of Richard C Maclaurin, president, and others, for an increase in the state appropriation for the Massachusetts Institute of Technology The resolve provides that there shall be paid annually, for ten years, to the institute the sum of $100,000, from January 1, 1912, to be expended under the direction of the corporation for the general purposes of the institute, the institute shall maintain forty free scholarships in addition to those already maintained

MR CARNEGIE recently wrote the board of trustees of the Carnegie Instituta that he is prepared to increase the endowment income $50,000 or $100,000 a year if it can be shown that any department is hampered from lack of funds The founder expects to visit Pittsburgh about May 1 to receive the report of the board.

AN alumnus, who wishes to remain anonymous, has given to Phillips Exeter Academy $18,744, with which to complete the Wentworth mathematical fund of $50,000 William

A Francis has been elected the first Wentworth professor of mathematics He has been professor of mathematics since 1892

THE Ohio house has passed the Cahill bill, which had previously passed the senate, providing for the compulsory teaching of agriculture in the common schools of villages and townships

ON February 15 and 16, about one hundred and sixty members of the Illinois general assembly went to the University of Illinois to make their biennial inspection A convocation was held in the auditorium, at which time addresses were given by various members of the house and senate In the afternoon a conference with members of the appropriation committee and heads of the departments was held, at which time the needs of the university were presented The university is requesting from the legislature this year for maintenance and general equipment $2,201,000, also for new buildings, the sum of $1,150,000, for maintenance of the College of Medicine, $200,000 In addition to these requests it also is supporting the request of the College of Agriculture for $1,575,750 for maintenance and equipment In addition to the above the mining interests of the state are supporting a bill proposing an appropriation of $240,000 for the construction of the mining engineering building and maintenance of the department of mining engineering. The ceramic interests are likewise supporting a bill proposing an appropriation of $45,000 for the department of ceramics

DR JOHN G BOWMAN, secretary of the Carnegie Foundation, has been elected president of the Iowa State University to succeed Dr. George E MacLean

THE Rev. Dr George Edward Reed has resigned the presidency of Dickinson College after twenty-two years of service.

RECENT appointments in the School of Mines of the University of Pittsburgh are Dr Charles R Eastman, of Harvard University, as professor of paleontology, Otto Emery Jennings, of the Carnegie Museum, as instructor in paleobotany, and James Z Zimmerman as assistant in mining Mr George T Haldeman, instructor in mining, has recently been appointed superintendent of the Mine Rescue Work of the Lehigh Valley Coal Company and Mr Edward L Estabrook, assistant in mineralogy, has been appointed instructor in petrology at Lehigh University

PROFESSOR VICTOR R GARDNER, head of the department of horticulture at the University of Maine, has accepted the appointment of associate professor of pomology at the Oregon Agricultural College, to succeed Professor C A Cole, who has resigned to take up industrial work

ERNEST GALE MARTIN, Ph B (Hamlin), Ph D (Johns Hopkins), has been promoted to an assistant professorship of physiology at Harvard University

DR TH PAUL, professor of chemistry at Munich, has been appointed director of the laboratory of inorganic chemistry at Leipzig, to succeed Professor Ernst Beckmann

DISCUSSION AND CORRESPONDENCE

THE AIR WE BREATHE IN BUILDINGS

TO THE EDITOR OF SCIENCE Two or more years ago my attention was drawn to the astonishing and unfortunate condition of the throats and tonsils of school children and the number of children who had adenoids This led, through a series of investigations, to a general study of the air which we breathe in buildings. This air we all know is, somehow or other, not as good for us, even under the best conditions of ventilation, as the open air

For example, children in open-air schools systematically show greater increases in the number of red blood corpuscles during the school term than during vacation The investigations of Benedict, Atwater, Paul, Heyman, Ercklentz and Flugge, and of Dr Leonard Hill, of the London Hospital Medical College, have given us a body of as yet undigested, although fundamentally important, information

Dr Gilman Thompson and Dr. Brennan, of New York City, have changed the death rates in pneumonia and certain other diseases by placing the beds of patients either out of doors

or next to open windows These two men think that we ought to do away with all systems of ventilation and use simply natural ventilation—open windows. On the other hand, Dr. Leonard Hill writes me as follows

I have not published in extenso my researches on ventilation and have only communicated the general drift of them to the Institution of Heating and Ventilating Engineers over here, in whose transactions my remarks appear

The whole point of my work is to force attention to the need of cool air of average humidity It is not the actual percentage of O_2 or CO_2 that matters, but the temperature, the humidity and the movement of the air in houses, schools, etc

I visited yesterday a London County council school in which is installed a Plenum system with separate shaft to each school room, giving a moving air at 67–60° Fahrenheit and about 70 per cent relative humidity All windows and doors are kept closed The result is admirable, lively, attentive children (at 4 P.M.) and masters looking fresh, no smell of human beings—this was only noticeable when one stood actually among the boys, not in the free spaces of the schoolroom The headmaster has had hardly any zymotic disease, and in every respect reports better conditions than in neighboring schools with no such efficient system The children are reported to eat more after coming to school

We know definitely that the difference between good and bad air does not consist primarily or to any great extent in variations of oxygen or carbon dioxide, and that there is no such thing as a subtle human poison (anthropotoxin) which varies in proportion to the CO_2.

We have tables which show the different temperatures and how air at, say, 32 degrees, with adequate relative humidity, becomes, when raised in temperature to, say 70 degrees, air practically without moisture It appears that one of two things must have happened—either the heat must have contracted the existing moisture or the capacity of the air for moisture has been vastly increased by the rise in temperature.

Practically all of the best manuals of the heating and ventilating engineers tell us that with a good system of ventilation the opening of windows causes only danger; yet, as a matter of fact, children in rooms so treated do not exhibit the distressing conditions referred to at the beginning of this letter

I have already secured and digested all of the literature to which reference is made in exhaustive bibliographies, indices, and the like, on the subject of air, changes in oxygen, CO_2, and so on, as well as the literature covering the relations of the vaso-motor system to the emotions on the one hand, and to skin circulation on the other

I believe that the larger part of the question as to why vitality is decreased indoors can be answered through the correlation of these facts, which I already have There are, however, certain facts which I have not, and which, so far as I have been able to find out, no one has studied I am not a physicist, and do not know—neither do I know whether the physicists know—the reason why raising the temperature of air increases its capacity for water—in fact, its thirst for water

I am writing to ask if any of the readers of SCIENCE know of any experiments which will throw any real light on the following questions

Is there any difference between steam and humidity? Does steam act strictly in accordance with the ordinary laws governing the movement of gases? Does humidity in the air act exactly as steam does? I suspect that it does not, because heat causes steam to expand, whereas, when we raise the temperature of the air its capacity for moisture becomes vastly increased, which shows either that the steam has contracted or that the air has been altered in such a way as to permit of its absorbing a larger percentage of moisture than it did before

I confess to a feeling of hesitation in presenting questions which must seem so elementary to your readers, yet when I presented to the American Society of Heating and Ventilating Engineers[1] some of the facts that we have recently discovered about the ventilation of school rooms in relation to the physical and mental condition of children they said that I

[1] *Heating and Ventilating Magazine*, February, 1911

was upsetting the very foundations upon which heating and ventilating science was built.

It seems as if there must be somewhere in existence the knowledge which we need at the present time. Man has become in a comparatively few years a preeminently house-abiding creature. He lives in localities which are paved, where there is little opportunity for evaporation, which is a necessary condition for human living. Present conditions are not right. Does any one know in what respect our present schemes of ventilation are wrong, why delicate children and tuberculous persons get well out of doors, and fail to do so in-doors, and what we need to do to make in-door living as healthy as out-door living? If we can find the answers to these questions we shall have discovered something which will affect the vitality of all the children, and ultimately of all the adults, who live in buildings throughout the civilized world.

Any reference to original sources which any of your readers can give will be most gratefully welcomed.

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"MUTATIONS" OF WAAGEN AND "MUTATIONS" OF DE VRIES OR "RECTIGRADATIONS" OF OSBORN

IT is important to distinguish clearly between what may be called the "mutations" of Waagen, the "mutations" of De Vries, and the rectigradations of Osborn. By careful examination of Waagen's original paper and the usage of this paper on the continent by subsequent paleontologists it appears certain that the mutations of Waagen are stages of transition between Linnæan species occurring in direct lines of phyletic ascent. These stages are distinguished by progress, although perhaps very slight in a number of different characters. The mutations of De Vries have not been distinguished in paleontology, but only in botany, and through botany extended to zoology. They represent the sudden or discontinuous jumps or saltations through which new characters arise. Definite direction is given to these characters only through selection. The "rectigradations" of Osborn are different in significance from either of the above, the term refers to the stages of single new characters occurring at definite points, hence originally termed by Osborn "definite variations." The mutations of De Vries can not be used by paleontologists, with whom the original term *saltation* would be preferable.

HENRY FAIRFIELD OSBORN

SCIENTIFIC BOOKS

Inheritance of Characteristics in Domestic Fowl. By CHARLES B. DAVENPORT. Carnegie Institution of Washington, Publication No. 121. Pp. 1 + 100, Pl. 1–12. 1909. Issued February 7, 1910.

This quarto volume contains a detailed account of the results of the continuation of the studies on inheritance in domestic poultry carried out by Dr. Davenport at the Station for Experimental Evolution at Cold Spring Harbor, the first instalment of the results of these investigations having appeared as Carnegie Institution Publication No. 52. A great mass of new and interesting facts are brought forth in the present work. The book is divided into twelve chapters, of which the first eleven deal severally with some of the characters which experience shows to be most difficult of definite analysis in respect to their hereditary behavior. Nearly every character discussed is one which at first acquaintance appears not at all to follow Mendelian principles (at least in their simplest form) in inheritance. Because of this fact they are of all the greater interest and significance to the student of heredity, and any systematic and thorough attempt at their analysis, such as is here made, is most heartily to be welcomed and commended, even though one may not be prepared to accept *in toto* the final interpretations reached. The extensive collection of facts brought together in this work loses none of its value if the theoretical interpretation should later be changed.

Chapter I. deals with the inheritance of the split or Y comb which appears in the progeny of a cross between a single-combed bird and one possessing a V or "horned" comb, such as

is found in the Polish fowl. The essential facts brought out are that the proportion of the median element to the lateral elements of the Y comb varies in the F_1 progeny all the way from 0 to 90 per cent. of median element In the F_2 and subsequent progeny the amount of median element is distinctly correlated with the amount present in the parents The author's interpretation of this is that median comb is imperfectly dominant over no-median comb, and that the degree (or potency) of dominance is inherited Chapter II deals with the inheritance of the extra toe found in various breeds of fowls The facts here are that while "extra toe" is sometimes dominant, it sometimes fails to dominate Lumping all statistics together, it would appear to be the case that the greater the degree of dominance of extra toe in F_1 the higher the proportion of polydactylous young produced in subsequent generations, thus apparently confirming Castle's conclusions regarding the inheritance of degrees of polydactylism in guinea-pigs Analysis of the data with reference to gametic constitution of the parents, however, leads plainly to the conclusion that "the average condition of toes in the offspring of second or later generation hybrids can not be used as evidence of inheritance of the degree of parental development of the toes, since these are dependent upon the same basal cause, namely, the hidden gametic constitution of the parents"

Chapter III deals with syndactylism, or "web foot" condition This character apparently segregates as though it were dominant to normal foot, though the dominance itself may fail to appear in F_1 Chapter IV deals with rumplessness, a character of certainly puzzling behavior in inheritance Here the author's earlier provisional conclusion that rumplessness is recessive is reversed, and now this condition is held to be dominant, the allelomorphic factors being "inhibitor of tail" and its absence. The principle of imperfection of dominance is adduced to explain the fact that the F_1 progeny are tailed. Some data regarding the inheritance of presumably congenital winglessness are given in the next chapter, but definite conclusions are not reached. The next two chapters present some very valuable evidence on the much-mooted problem of the effectiveness of selection of fluctuating variations The characters dealt with are booting (feathering of legs) and nostril form. The facts here are of great importance and almost unique in the literature in that *they give for a bisexual organism data as to definite grades of the character in individuals of known gametic constitution with respect to this character* The results show at once the inherent fallacy of the basic assumption of the biometric method of dealing with inheritance, which tacitly assumes that all somatic variations are of equal hereditary significance,[1] and at the same time the failure of selection of fluctuating variations within a *gametically homogeneous* population (= the nearest thing to a "pure line" one can ever get in a bisexual organism) to produce any result. If all degrees of booting in parent and offspring of all sorts of gametic constitution are lumped together in one table there is a sensible correlation between parent and offspring. One might hence conclude that grades of booting are inherited in a blending fashion, and could be genetically modified by systematic selection of slight "favorable variations" If, however (and in showing this with such precision and clearness lies one of the most valuable contributions of the work), a table is made in which the individuals included are homogeneous gametically there is no correlation whatsoever between parent and offspring in respect to grade of booting The offspring of parents with "much boot" have on the average no more of the character than those whose parents have "little boot," provided both sets of parents are gametically alike as regards "booting." Under these circumstances one would obviously not make progress in selecting for increased booting Nostril form shows the same thing.

The next two chapters deal with crest

[1] Cf. a more detailed discussion of this point in a paper entitled "Biometric Ideas and Methods in Biology Their Significance and Limitations," which is shortly to appear in "Scientia"

(showing that this structure depends upon two gametic characters, instead of one as hitherto supposed), and with comb-lop (showing that the direction of the lop is not apparently inherited). Chapters X and XI deal with various phases of the inheritance of plumage, color and pattern. A general gametic formula for poultry coloration is worked out and evidence presented in its favor. Data are given regarding the inheritance of certain pattern types.

The last chapter is devoted to a general discussion of certain theoretical matters of prime importance. Stress is laid upon the possible significance of "inhibitors" in addition to "determiners" in ontogeny. The "principle of imperfect dominance" is discussed at length. One fancies that here is where the greatest disagreement will be found amongst students of the subject. The reviewer, frankly, is unable to see that degree of heuristic worth in this concept which the author seems to find. It seems possible to account for all the facts on which this concept rests in other ways, not any the less in accord with Mendelian principles. Virtually these facts amount to an *apparent* failure of segregation. One may safely say that practically all students of inheritance whose study involves a real, first hand acquaintance with the living, breeding organisms are deeply impressed with the precision and definiteness of segregation *generally*. When apparent exceptions to the law of precise segregation occur one's zeal is aroused to discover the cause. There is a wide range of physiological factors beyond such things as "imperfection of dominance" which must be considered here (*teste* the work of Tower and of Tennent, for example). Probably every one will admit that the data now available do not permit any final conclusion as to what are the primary factors involved in causing apparent exceptions to Mendelian principles, either in general or in particular cases. What clearly are needed are more of such extensive collections of definite experimental data as are furnished in the work under discussion. We may well observe that caution expressed by Robert Boyle as an apology for not taking a more decided stand on theoretical questions: "having met with many things for which I could assign no probable cause, and with some for which many different ones might be alleged, I dare speak positively and confidently of very few things except of matters of fact."

RAYMOND PEARL

The Teaching Botanist. A Manual of Information upon Botanical Instruction. By WILLIAM F. GANONG, Ph.D., Professor of Botany in Smith College. Second edition. Pp. 12 + 439, illustrated. New York, The Macmillan Company. 1910.

At a time when the teaching profession is being assailed on all sides with demands for a practical education, and when the meaning of "practical" is, in the main, materialistic, those teachers in botany still committed to ideals, but perhaps finding difficulty in harmonizing them with the proper demands of those seeking immediately useful training, will find a champion in the author of "The Teaching Botanist." Professor Ganong has worked long and consistently with the avowed purpose of trying to solve the problem of the content and method of an elementary course in botany. He may therefore be looked upon by the teacher seeking guidance as among the safest and surest. He would be the first to disavow the claim that he has quite answered the question to which his book is a large and satisfying reply, but we do not hesitate to say that he is far along on the right track.

"The Teaching Botanist" in its present form is called a second edition, but is very largely a rewriting. On the side of information, which the teaching botanist desires to have respecting the materials with which he deals, it has been brought down to date. The results of actual teaching experience during the last few years have been set down. In this sense the book is practical, in some directions almost encyclopedic, and will stand in good stead to one who is planning courses or equipping a laboratory. This will be understood to include also the matter of books, which are well discussed, and of which a full

list, so far as pertains to the teaching of elementary botany, is provided. Since school boards are sometimes in a hurry for data, it would have been well to facilitate the teacher's task by indicating in the list itself the relative values of the various books, so that a limited choice might be quickly made. This end is, however, largely attained in the reading of a chapter, but in a less concise way.

A very valuable addition in the present book are the suggestions given for the growing of plants in windows in pots and boxes. But few schools are able to do more than this, and any practical help in this apparently easy, but really rather difficult matter, will prove very welcome, especially as this part of the text comes from the hand of Mr. Edward J. Canning, than whom few are more skilful in horticultural practise. An additional suggestion will not be amiss, that tin cans are usually better than pots for house culture. Indeed, they are exceedingly useful for much laboratory experimentation. The jagged rims may be melted off, while a coat of asphalt paint will make them sightly.

During the past few years Professor Ganong and some of his more advanced students have systematically investigated the commoner plants with particular reference to their adaptability for demonstration and laboratory experimentation, while Professor Ganong himself has worked arduously in the perfection of apparatus of more refined type adapted to school and college use. The excellent data and apparatus thus obtained are available in *The Botanical Gazette* and in another book, "Plant Physiology," properly to be regarded as a companion volume to "The Teaching Botanist," and which should, with this, be in the hands of every ambitious teacher.

The second part is devoted to a detailed discussion of a synthetic course, the content of which is widely known through the work of the Committee on Education of the Botanical Society of America, of which Professor Ganong is the chairman. The method of presentation is left, in the report of that committee,[1] as a matter of choice to the teacher, but the book before us will do much to advance the recognition of the principle of synthesis. The account, covering 150 pages, may be regarded as a condensed log of a successful teacher, and gives the practical pedagogy on every difficult and important point. The fundamental principle, that of synthetic treatment of allied structural and physiological topics, has much to commend it, the chief of which is the overwhelming importance of physiology. The reviewer is glad that the efforts of Professor Ganong have been in this direction, since it is principally this phase of botanical science which must come to the front in the botany taught in schools of agriculture. These are rapidly multiplying, and many young teachers are going out year by year into this work who need much help along the right path.

Of most permanent importance, in the opinion of the reviewer, is the chapter on the Training and Traits of the Good Botanical Teacher. It is full of good common sense coupled with a clear vision of the ideal. The teacher who is troubled because he can not do research will find in this homily some other matters to think about and other ways of advancing his science than in striving to do the work of others whose business it is. There must be a great majority of good botanical teachers whose chief interest is the development of the teaching aspect of the science, and whose effort is legitimately expended in this way. To such Ganong brings a message.

FRANCIS ERNEST LLOYD
ALABAMA POLYTECHNIC INSTITUTE

[1] This report is printed as an appendix.

Lehrbuch der anorganischen Chemie. Von Professor Dr. H. ERDMANN, Direktor des Anorganisch-Chemischen Instituts der Königlichen Technischen Hochschule zu Berlin. Fünfte Auflage (Dreizehntes bis Sechszehntes Tausend). Mit dem Portrat des Verfassers in Gravure, 319 Abbildungen, 95 Tabellen, einer Rechentafel und Sieben Farbigen Tafeln. Braunschweig, Friedrich Vieweg und Sohn. 1910. Pp. 805. 16 Marks.

A new edition of "Erdmann" will be welcome to every chemist who has read the earlier editions This book is well known but not as well as it deserves When the first edition appeared thirteen years ago, it was recognized as the best existing one-volume text-book of descriptive chemistry, each succeeding edition is an improvement on its predecessor

The present fifth edition has a melancholy interest as the last work of the author Erdmann wrote the preface but a few days before his accidental death by drowning while sailing on a lake near Berlin. He was an active worker in several fields of chemistry, but will be best remembered for the "Lehrbuch"

What are the chief features of this book? It is written for advanced students, not for beginners It is essentially descriptive It opens with a condensed but admirably clear and complete statement of physical-chemical laws and methods contained in an introduction of 84 pages The remainder of the book treats of the elements and their compounds, and is chiefly descriptive, both chemical and physical properties being considered, technical methods and experiments profusely illustrated by excellent diagrams form a prominent feature of the book.

To give the reader an idea of the scope of the book, the headings of the paragraphs of one of the shorter and simpler chapters may be given It is worth the reader's attention The chapter on hydrogen fills 21 pages, it includes 4 tables, 22 diagrams and a beautiful colored plate of the spectra of hydrogen, oxygen and nitrogen The chapter begins with the present and the old names of the element in German and the present name in English, French, Russian and Spanish The physical constants follow; then the following paragraphs—occurrence in the universe, on the earth free and combined, relative weights of chief elements in earth's crust compared with relative number of their atoms, discovery, preparation, hydrogen as by-product; as unit of gas densities, free hydrogen has the density 2, specific gravity of hydrogen compared with air and with water—determinations of Regnault, Rayleigh, Cooke, Leduc, Morley and Thomsen; normal pressure and normal temperature, polarization, molecular speed, diffusion, effect of change in temperature and pressure on expansion, hydrogen the legal basis of thermometry, Kelvin's phenomenon, liquid hydrogen, critical pressure, chemical activity, action on water, on the halogens, on oxygen, combustible, metallic modification of hydrogen, nascent state, as unit of atomic weights, density in palladium alloy compared with densities of alkali-metals, as reducing agent, practical uses, lifting capacity of balloons, filling balloons, hydrogen as fuel, spectrum Then follows the section on experiments and technique with the diagrams In addition to the familiar apparatus and experiments may be mentioned Bucher's apparatus for quick generation of large volumes of hydrogen from aluminium and sodium hydroxide, or from calcium hydride (hydrone), Kammerlingh-Onnes's apparatus for liquefying hydrogen, the triple-walled Weinhold modification of the Dewar flask, experiments with liquid and with solid hydrogen, griessheim process for preparation of large quantities of hydrogen

Not only do we find matter in this book which is not given in other one-volume textbooks, but we find something new concerning nearly every element and important compound which was not in the last edition, for the author introduced a reference to every important discovery if it appeared in the journals before the edition went to press

The elements are treated in the main in the order of the periodic system, though Erdmann makes but little use of the system, describing it in the closing chapter His own arrangement of the elements in a spiral curve—given on a separate table—is interesting.

A singular flaw in the book is the lack of a proper treatment of the subject of steel The data given are scant, scattered and empirical. Thus vanadium steel is barely mentioned and only in the chapter on vanadium. This is, however, but a small matter compared with the general excellence of the book. Translations are not known to the reviewer The frequent appearance of new editions has probably de-

ferred translators. The cost of adequate production might deter publishers Most of those who need a book of this kind would prefer to use the original

The publishers of the book have used a thin, tough, opaque paper and a close clear type, thus bringing into one volume of readable size matter which with other paper and type would fill two volumes The diagrams and particularly the colored spectra plates are very fine The price of the book is comparatively very low

E RENOUF

Sewage By A. PRESCOTT FOLWELL Sixth Edition 8vo, pp 506, cloth New York, John Wiley & Sons $3 00

The first 358 pages of this new edition are devoted to detailed descriptions and directions for the design, construction and maintenance of sewers and their various appurtenances, as used for the removal of those wastes that are conveyed from the household by water-carriage in underground channels The book is a comprehensive one in this respect, serving not only as a useful guide to the student in sanitary engineering, but also as a valuable reference book to the practical engineer and the sanitarian

Specifications, forms of contract and procedures for putting such work under contract are given in a manner to engage the attention of the city official Cost data are analyzed with much detail and should prove of interest to engineers and contractors

Since the first edition of this book appeared eleven years ago, there have been a number of features which have arisen for discussion, and these have been judiciously embodied in the sixth edition From the strictly engineering standpoint, they relate particularly to the use made of concrete

The chapters on the ventilation and flushing of sewers are well prepared They wisely advocate the construction and operation of sewers so as to keep as fresh as possible both the sewage itself and the air within the sewers The importance of guarding against putrefaction in sewers and sewer-connections is becoming more and more appreciated, particularly by those who have to do with sewage purification It is gratifying to note that the old idea of trapping the main house drains is not favored, but preference is given to ventilating the street sewers through the house connections with pipes extending to above the roofs, as is the custom on the continent of Europe The discussion of this subject should prove of interest to sanitarians

Pages 359–492 are devoted to the subject of sewage disposal and have been practically rewritten All the principal aspects of sewage disposal by dilution and by treatment in works of artificial construction of various types are well outlined The book is not intended to be an exhaustive treatise on sewage disposal, but it is a well-balanced review of the subject which will prove serviceable to students in sanitary science, as well as to health officers, city officials or others interested in the general subject

The book has been brought well up to date, as is shown by the statements given with respect to the Emscher tanks for the clarification of sewage as recently practised in western Germany with a marked degree of success, showing much improvement over the so-called "septic tanks"

The point of view that prevails generally throughout the closing chapters of the book is a practical one Experiences with sewage disposal on a large scale are used frequently in illustrating methods and processes

Without doubt, the enlarged edition of this book should prove very useful in the classroom and in the library of those who are interested in the advancement of sanitary science. The book is well edited and indexed, and it contains 46 illustrations and 31 tables

The arrangement of the book for class-room use will doubtless appeal to teachers, as it shows the results of Professor Folwell's successful experience for some years as head of the department of civil engineering of Lafayette College, prior to his taking the editorship of the *Municipal Journal and Engineer*

GEO W FULLER

SCIENTIFIC JOURNALS AND ARTICLES

THE opening (January) number of volume 12 of the *Transactions of the American Mathematical Society* contains the following papers

L E Dickson "An invariantive investigation of irreducible binary modular forms"

W H Bates "An application of symbolic methods to the treatment of mean curvatures in hyperspace"

H F Blichfeldt "On the order of linear homogeneous groups (fourth paper)"

J L Coolidge "The metrical aspect of the line sphere transformation"

Edward Kasner "Natural systems of trajectories generating families of Lamé"

L E Dickson "A fundamental system of invariants of the general modular linear group with a solution of the form problem"

R D Carmichael "Linear difference equations and their analytic solutions"

THE February number (volume 17, number 5) of the *Bulletin of the American Mathematical Society* contains Report of the fourth regular meeting of the Southwestern Section of the society, by O D Kellogg, Report on "University courses in mathematics and the master's degree," by the American sub-committee of the International Commission on the Teaching of Mathematics, Review of Doehlemann's Geometrische Transformationen, zweiter Teil, by Virgil Snyder, Shorter Notices Sylvester's Collected Papers, Vol III, and Bachmann's Niedere Zahlentheorie, zweiter Teil, by L E. Dickson, Burali-Forti and Marcolongo's Eléments de Calcul vectoriel, by E B Wilson, Lebon's Gaston Darboux, by J W Young, Killing and Hovestadt's Handbuch des mathematischen Unterricht's, by D. D Leib, Amodeo's Analisi algebraica elementare, by C L E Moore, Rietz and Crathorne's College Algebra, by J V McKelvey; Planck's Prinzip der Erhaltung der Energie, second edition, by E B Wilson. "Notes", "New Publications"

THE March number of the *Bulletin* contains Report of the seventeenth annual meeting of the society, by F N Cole, Report of the winter meeting of the Chicago Section, by H E. Slaught; Report on "Preparation for research and the doctor's degree in mathematics," by the sub-committee of the International Commission on the Teaching of Mathematics, Shorter Notices Frankland's Theories of Parallelism, by D E Smith, Vogt's Synthetische Theorie der Cliffordschen Parallelen, by E B Cowley, Bruns's Gruppenschema fur zufallige Ereignisse, by H L. Rietz, W W. Johnson's Elementary Treatise on the Differential Calculus, by E W Ponzer, Becker and Van Orstrand's Hyperbolic Functions, Fabry's Problèmes et Exercices de Mathématiques générales, and Couturat's Internacione matematikal Lexiko en Ido, by J B Shaw, Richarz's Anfangsgrunde der Maxwellschen Theorie, by E B Wilson "Notes", "New Publications"

THE FIFTH ANNUAL REPORT OF THE PRESIDENT OF THE CARNEGIE FOUNDATION

PRESIDENT PRITCHETT'S annual report gives a full and clear statement of the business of the Carnegie Foundation for the Advancement of Teaching during the year ending November 30, 1910, and includes an essay on the relations of colleges and secondary schools

The University of California, Indiana and Purdue Universities, and Wesleyan University have been added to the accepted list of the foundation The two state universities—for Indiana and Purdue form together essentially one state university—obviously meet standards which allow the admission of colleges such as Beloit, Carleton, Coe, Dickinson, Drake, Drury and Knox The tax-supported universities previously admitted are Michigan, Wisconsin, Minnesota, Missouri and Toronto It seems to the present writer most unfortunate that the executive committee of the foundation should prescribe to the state universities what they must do in order to receive pensions Illinois has been told that it must break the agreement which it made with the professors of the medical school in Chicago, Ohio that it must reconstruct its educational policy, and the like It is to be hoped that those in control of the state universities will resent such dictation Indeed one can not altogether dismiss the suspicion that the

officers of the foundation have the same hope, in order to be released from obligations which they could not meet.

Wesleyan University has amended the charter which made it ultra-denominational—for it required not only the president and a majority of the trustees, but also a majority of the professors to be members of the methodist episcopal church—and although one fourth of the trustees are elected by the conferences of the church, it has complied with the rules of the foundation Other institutions which are altering or trying to alter their church affiliations should know that the foundation will be very cautious in assuming further financial responsibility

This appears to be at last clearly acknowledged by the president and the executive committee The president makes the acknowledgment retroactive when he writes

In every report issued by the Carnegie Foundation, the effort has been made to call the attention of colleges and universities to the fact that the endowment in the hands of its trustees would provide at most an adequate retiring allowance system for only a small minority of the institutions in the United States and Canada bearing the name college or university This was most strongly urged even in the First Annual Report.

But in his first annual report, President Pritchett estimated that with the original endowment the foundation could accept from one hundred to one hundred and twenty institutions,[1] including payment of pensions for length of service He wrote

It may therefore be safely assumed that while the income of the Foundation is sufficient to carry out the original plan of the Founder it is not sufficient to extend the system of pensions, at least at first, beyond the scope which he indicated in his letter of gift It would seem therefore clearly the true policy of the Trustees at the inauguration of the Foundation to work within these limits, giving a generous interpretation to the terms "sectarian" and "state" control

In his letter of gift, Mr Carnegie wrote· "Expert calculation shows that the revenue will be ample" "to provide retiring pensions for the teachers of Universities, Colleges and Technical Schools in our country, Canada and New Foundland"

The state of the finances of the foundation is shown in the report of the treasurer, from which it appears that the receipts for the year were $543,881 and the expenditures $538,148, leaving a surplus income less than $6,000 The obligations undertaken for the current year leave a deficit of nearly $100,000 This will doubtless be met from the income of the further five million dollars which Mr Carnegie has consented to give for tax-supported institutions He wrote to the president of the foundation on March 31, 1908 "I understand from you that if all the State Universities should apply and be admitted Five Millions more of five per cent bonds would be required" But there are eighty-three institutions supported by states and provinces, of which but eight have as yet been admitted to the accepted list of the foundation.

If such of these institutions are accepted as fulfil the educational requirements originally set by the foundation, the income next year would not meet the expenses, and thereafter the deficit will increase at a rate not less than $100,000 a year It will be necessary for Mr Carnegie to give at least two million dollars each year in order that the income may meet the increased charges

Under the circumstances it is not surprising that the executive committee has voted that it is not expedient in the future to grant retiring allowances outside of the accepted list, except in cases of especial significance in institutions whose standards are so advanced that within a short time the institution will be ready to apply for admission to the Foundation.

How incompletely even such a great gift as Mr Carnegie's establishes a pension system for higher education throughout the country is illustrated by the fact that Knox College is the only institution accepted in the state of Illinois and Tulane the only institution south of Maryland and Missouri.

The financial inability of the foundation obviously accounts for the discontinuance of

[1] More than existed, having the educational standards required by the foundation, and being non-denominational and non tax supported.

the length of service pensions What needs explanation is why they were established, why they were discontinued in the manner adopted and why they were not paid to those to whom they had been promised Suppose that Mr. Carnegie in order to get better domestic servants and at lower wages had promised that those who wished could retire after twenty-five years of service with half wages If he found that the arrangement did not work well or that he did not have enough money to keep up his establishment, he might very well have employed no new servants on these terms But would he have broken his engagement with those who had served part of the time; and, if so, what would have been the decision of the courts if suit had been brought?

In his report Dr Pritchett dismisses the breaking of the pledges of the foundation lightly with the single remark

> The experience of the year has confirmed in the judgment of the trustees the wisdom and essential justice of the action taken a year ago

Now this is a truly remarkable, indeed an almost incredible state of affairs. The present writer has discussed the matter with some two hundred university professors in the course of the past year, and so far as he remembers not a single one of them regarded the action of the trustees as other than unwise and unjust In the act of incorporation the objects of the foundation are stated to be to provide pensions of two kinds. (1) for long and meritorious service and (2) for old age, disability or other sufficient reason, and further "to do and perform all things necessary to encourage, uphold and dignify the profession of the teacher and the cause of higher education" In the method used to give up the pensions for length of service the foundation has certainly not fulfilled the obligations specified in the second part of its charter

It is obvious that unless Mr Carnegie greatly increases the endowment of the foundation it can not meet its present obligations. They obtain most of all in the case of the younger men now entering the academic career in view of its promises It will doubtless be necessary to give up the retiring allowances, for age and confine them to disability The present writer does not regret this, for reasons which he has fully stated (SCIENCE, April 2, 1909)

Retirement at the age of sixty-five has substantially the same drawbacks as retirement after twenty-five years of service Men who are less competent or who are not in favor with the administration will be retired, and instead of security and loyalty, there will be unrest and bitterness The president will be quick to retire professors because their pensions are not paid by his institution, but from an outside source There is no more reason for retiring professors at sixty-five than justices of the supreme court There should be pensions (or still better full salaries after long terms of service) for disability, but these should be paid by the university It would have been far better if the Carnegie Foundation had given its income as an endowment to one institution after another for the establishment of a pension system Its present financial difficulties would have been avoided, and the dangers of a centralized autocracy would have been escaped

It is to be hoped that when the trustees of the foundation abandon the retiring allowances at the age of sixty-five years, they will do so in a manner that will "encourage, uphold and dignify the profession of the teacher and the cause of higher education"

J. MCKEEN CATTELL

SPECIAL ARTICLES

THE TYPE OF COLUMBINA SPIX

A FEW years ago I discussed the question of *Columbina vs Chæmepelia* in *The Auk*,[1] contending that the designation of *Columba passerina* Linn by Gray in 1840 as the type of *Columbina* was valid, and that his later designation of the same species as the type of *Chæmepelia* rendered *Chæmepelia* (Swainson, 1827) a synonym of *Columbina* (Spix, 1825) The genus *Columbina* originally contained four species, all described as new, one of

[1] Vol XXV, 1908, pp 301–306

which (*griseola*) proves to be only a slightly differentiated subspecies of *C passerina* For many years, or until the custom came in of recognizing subspecies, the real status of *griseola* was that of a synonym of *passerina*, which up to a recent date[6] had a commonly recognized range extending from the warmer parts of the United States south through the West Indies, Central America and South America to Paraguay and Peru, thus including the type locality of *griseola* When the original *passerina* came to be divided into numerous subspecies, *griseola*, as recognized by recent leading authorities, became *Chæmepelia passerina griseola*

In my paper cited above I stated that I could "see no reason why *Columbina griseola* = *Columbina passerina griseola* (Spix) may not be properly taken as the type of *Columbina*, in accordance with rule *d* of Art 30 of the International Code respecting the equal availability of species and subspecies as types." I find it is now questioned whether this statement, owing to its form, can be taken as really designating a type for *Columbina*, and take this opportunity of stating that this was its intention To leave no doubt, I may here add *Columbina* Spix, 1825, type *C griseola* Spix = *Columbina passerina griseola* Spix

But there are other complications hovering about the type of *Columbina*, and about the propriety of the above designation, on the ground that the question is one partly of zoology and partly of nomenclature In other words, that *griseola* may not be a subspecies of *passerina* but possibly a distinct species, or a subspecies of some other species This question could not well have arisen except for a mistake made by Bonaparte, in 1854, and followed by nearly all authors for the next half century He recognized and described a species under the name "*griseola* Spix" which was not only *not* the *griseola* of Spix but bears to it no very close relationship, it being in reality the *Columba minuta* of Linnæus To this extent, and no further, is the type of *Columbina* a question of zoology, for the type of *griseola* Spix is still extant and proves to be a young female of the *passerina* group, or of "*passerina*" as formerly recognized[6]

J. A ALLEN

[6] Cf. Salvadori, Brit Mus Cat. Birds, XXI, 1893, p 477.

[6] Cf Hellmayr, Abhandl d II Kl d. k Akad Wiss, XXII, Abb. iii, 1906, p 697

ANOTHER SEX-LIMITED CHARACTER IN FOWLS

IN view of the number of sex-limited characters recently recorded, the report of another one may be of interest even though the experiment has not yet gone beyond the first generation

The Brown Leghorn fowl has nearly the same color as the wild *Gallus bankiva* It is a sexually dimorphic breed, with black and reddish or yellowish-bay the chief colors in the male, and with the female lighter in color and showing a characteristic black and yellowish-brown pepper-and-salt pattern on the back and wings The Columbian Wyandotte has both sexes white, with black in the neck, wings and tail

When these two breeds were crossed there were three different classes of birds in the F_1 generation There were brown females resembling the Brown Leghorn females, and gray males and females resembling the Columbian Wyandottes but having considerable black mixed with the white ground color, thus giving a grayish effect These came in the following way·

Brown Leghorn ♂ + Columbian Wyandotte ♀
= 10 gray ♂ and 8 brown ♀
Columbian Wyandotte ♂ + Brown Leghorn ♀
= 9 gray ♂ and 3 gray ♀

It will be seen that these results agree with Goodale's experiment,[1] since the gray males show considerable red or brown on their backs, as was the case with the corresponding birds in his cross between White Rocks and Brown Leghorns.

The gray females, however, unlike his barred F_1 females, also show a little brown, though this is not conspicuous They also show some

[1] *Proc Soc Exp Biol. and Med*, Vol 7, No 5, May 18, 1910

of the Brown Leghorn pepper-and-salt pattern The F_1 brown females are yellower on the fore part of the back and wings than are the Brown Leghorns They seem to resemble some of Goodale's F_1 brown females, but none are as dark as some of his Perhaps such would have appeared if a larger number had been raised

These results show that the gray pattern behaves as the barred and brown ones have already been shown to do The results may be explained as the others are Represent the gray factor by G, the brown by B, and femaleness by F Assume that both G and B are spurious allelomorphs to F[3]

The representation will be

Brown Leghorn ♂—gBf gBf
Columbian Wyandotte ♀—Gf gF
produce { gBf Gf — gray ♂ ; gBf gF — brown ♀ }

Columbian Wyandotte ♂—Gf Gf
Brown Leghorn ♀—gBf gbF
produce { Gf gBf — gray ♂ ; Gf gbF — gray ♀ }

Nothing has yet appeared to show the composition of the Columbian Wyandotte with regard to B

Several years ago a Columbian Wyandotte male was mated to a female of the Silver Laced Wyandotte breed, which has black wherever the Columbian has it and also has the feathers of the back, breast and shoulders white, edged or laced with black The F_1 birds were nearly typical Columbians, one of the males being near enough to that color to win a prize as a Columbian at a poultry show Some of the females, however, showed black edging on the tips of some of the feathers of the back One of these was mated to a Columbian Wyandotte male, and the result was practically the same as in the F_1 generation. Unfortunately, this cross was not made in the right direction to bring out the sex-limited character, but the result agrees well with that described above

A H. Sturtevant

Columbia University,
January 2, 1911

[3] Goodale's work (mentioned above) has shown that B is sex limited

THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

THE FORTY-THIRD GENERAL MEETING OF THE AMERICAN CHEMICAL SOCIETY AND SECTION C

The forty third general meeting of the American Chemical Society and Section C of the American Association for the Advancement of Science was held at Minneapolis in the Chemistry Building at the University of Minnesota, December 28–31, 1910 The first general meeting was called on Wednesday morning

About 300 members and guests registered for the meeting Approximately 275 of these were members of the society The meeting was a thoroughly good one from the consideration of attendance, number and quality of papers, and the generally good time which every one enjoyed because of the generous hospitality of our hosts

The council of the society met on Wednesday afternoon and Thursday evening, when the general business and election of officers were considered

Wednesday evening the Minneapolis Section of the society extended a complimentary smoker to the visitors at the Commercial Club Complimentary luncheons were also prepared for the visitors during each day of the session

On Thursday and Friday afternoons excursions were made to the Minneapolis flour mills, International Stock Food Factory, St Anthony Falls Power Company, the linseed oil and paint companies On Saturday afternoon the visitors enjoyed a free excursion to the many points of interest about Minneapolis and St Paul

The following papers and addresses were given before the general meetings

"A Universal Law," President W D Bancroft

"Report for the International Committee on Atomic Weights," F W Clarke

"The Lost Arts of Chemistry," W. D Richardson

"The Basis of Industrial Efficiency," Arthur D Little

"Synthetic Metals from Non-metallic Elements," Herbert N McCoy

"Progress in Food Chemistry," H E Barnard

"Mechanism of Cell Activity," Carl L Alsberg

"Waste Wood and some of its By products," Geo B Frankforter

"The Formation of Carbohydrates in the Vegetable Kingdom," Wm McPherson

"The Efficiency of the College Graduate in the Chemical Industry," Chas F Burgess

BIOLOGICAL SECTION

Carl L Alsberg, *chairman*

I K Phelps, *secretary*

The Lecithin Content of Milk under Pathologic Conditions L W FETZER

The results show that milk obtained from animals suffering from mastitis contains less lecithin than the milk obtained from healthy animals It was further noted that where a diminution in the lecithin content took place there was a corresponding decrease in the fat content

The Antitoxic Action of Certain Nutrient and Non nutrient Mineral Bases with Respect to Plants M M MCCOOL

Extensive data were presented with reference to antagonistic action of different bases with respect to plants In the experiments reported the Canada field pea has been made the indicator, and a complete comparative study has been made of the growth of tops and roots in solutions of the different bases as follows (1) solutions containing single bases in concentrations varying from those which are non toxic to those which practically prohibit growth, (2) solutions containing two bases at concentrations including those toxic when employed alone

It was found that mutual antagonism occurs in the following combinations

Ca *vs* Ba	Ca *vs* NH_4
Ca *vs* Fe	Ca *vs* Sr
Ca *vs* K	K *vs* Sr
Ca *vs* Mg	Na *vs* K
Ca *vs* Mn	Na *vs* Mn
Ca *vs* Na	Na *vs* Sr

To express the above in terms of single antagonism, it is obvious that the second term in each of these systems could be placed first, but the arrangement given indicates that the base first given is the most important term in the combination with respect to antagonistic action

The toxicity of the various bases in distilled water, full nutrient solutions, and soil cultures have been determined likewise as additional controls upon the preceding results The tests of all of these bases in dilute nutrient solutions of any type, or in soil or sand cultures, diminishes or prevents the injurious action of the concentrations toxic in water

The Oxidative and Catalytic Powers of Soils and Subsoils M X SULLIVAN and F R REED

Surface soils have the power to oxidize easily oxidizable substances such as aloin, guaiac, pyrogallol, hydroquinone, etc When ten grams of soil are shaken with 50 c c of a 0 1 per cent. water solution of aloin, the yellow color of the aloin is changed to cherry red. On allowing the soil to settle, the solution can be filtered and the depth of color determined in the colorimeter Broadly speaking, the oxidative power of the soil is symptomatic of a good soil condition, since soils of good productivity have in general good oxidizing power, while soils of poor productivity have, as a rule, poor oxidizing power. Subsoils have little, if any, action on aloin, though occasionally the oxidizing power of the subsoil may be as great or greater than the corresponding surface soil The catalytic power of the soil or its capacity for decomposing hydrogen peroxide with the liberation of free oxygen is roughly parallel to the oxidative power in that soils known to be of good productivity have strong catalytic power, while poor soils have weak catalytic power As compared with surface soils, the subsoils have, for the most part, a weak catalytic power. The oxidative and catalytic powers of the soil are analogous to these powers in plants and animals and are modified in much the same way

Enzymotic Activities in Soils OSWALD SCHREINER and M X SULLIVAN

Within the bodies of microorganisms in plant roots and plant débris, in worms and animalcules, enzymes of various kinds must exist. Evidence of various enzymotic activities, proteolytic, amylolytic, inverting, cytolytic, lipolytic, etc, may be seen in many soils Starches, sugars, cellulose, fat and protein are speedily changed or disappear, and in many cases, especially of proteins, some of the products of digestion may be found in the soil The oxidizing and catalytic activities of the soil, comparable to the same activities in plants and animals where it has been attributed to enzymes, is especially noticeable and easy of demonstration As yet no satisfactory means have been obtained of extracting enzymes from soil to any great extent, though in soils recently cropped there is some slight evidence of the presence of enzyme like substances in the glycerine extract of the soil

Soil Organic Matter as Material for Biochemical Investigation · OSWALD SCHREINER and EDMUND C SHOREY

Attention is called to the complexity of the organic matter of soils and the fruitful field of research that it offers for biochemical investiga-

tion. The importance of the chemical character of the organic matter of the soil is considered under four heads: its effect on crops, its effect on the bacteria and fungi of the soil, its influence on the physical properties of the soil, and its relation chemically to the mineral ingredients of the soil. By the application of the biochemical methods there have been isolated in this research twenty definite organic compounds thus far from that portion of soil organic matter included in the term humus. A chart showing the classification of these compounds, as well as methods of separation, was shown. The compounds comprised paraffin hydrocarbons, acids, alcohols, esters, carbohydrates, hexone bases, pyrimidine derivatives and purine bases.

The Isolation of Creatinine from Soils: EDMUND C. SHOREY.

Creatinine has been isolated from several soils by the following method: An extract made by shaking the soil for half an hour with 2 per cent. sodium hydroxide was neutralized with acetic acid and filtered. To the filtrate a small quantity of dextrose was added, heated to boiling, and Fehling's solution added until the precipitate formed was red in color. The precipitate after washing was decomposed with hydrogen sulphide and the filtrate from the copper sulphide concentrated under reduced pressure. Creatinine, if present in the soil, is in this filtrate together with purine bases and can be separated as creatinine zinc chloride and creatinine prepared from this by treatment with lead hydroxide. The creatinine was identified by the characteristic crystalline appearance of the zinc chloride compound and by the Jaffe, Weyl and Salkouski color reactions.

The Toxic Action of Organic Compounds as Modified by Fertilizer Salts: OSWALD SCHREINER and J. J. SKINNER.

The action of fertilizer salts in restraining the harmful influence of certain organic compounds was studied, as well as the effect of the compounds on absorption. The culture solutions comprised all possible ratios of the three principal fertilizer elements: phosphate, nitrate and potassium, varying in 10 per cent. stages.

The various fertilizer salts acted differently in overcoming the respective harmful effects of the toxic compounds. The mainly phosphatic fertilizers were the most efficient in overcoming the cumarin effects, the mainly nitrogenous fertilizers in overcoming the vanillin effects, the mainly potassic in overcoming the quinone effects.

The cumarin depressed potash and nitrate removal from nutrient solution more than phosphate, the quinone, on the other hand, depressed phosphate and nitrate more than potash, the effect of vanillin was not determined in this regard. It is interesting to mention that dihydroxystearic acid, which, as previously reported, appears to act much as vanillin did, depressed phosphate and potash more than nitrate. In this respect again the influence of the various harmful substances was different.

The conclusion is drawn that different toxic substances produce definite effects in their action on plants and that the effects are modified differently by the different fertilizer salts.

On the Catalase Content of Tissues and Organs after Prolonged Fasting: P. B. HAWK, Laboratory of Physiological Chemistry, University of Illinois.

The study embraced the examination of the tissues and organs of four dogs which were subjected to periods of fasting ranging from 7 to 104 days. A pup one month old was subjected to a 7 day fast, a dog from one to two years old served as the subject of the 30 day fast, whereas the longer fasts were carried out upon mature animals. The dogs were fed a constant water ration, the water being introduced by means of a stomach tube.

At the termination of the fasting periods chloroform water extracts of the tissues and organs were prepared and their catalase values determined. The tissues and organs of normally nourished dogs were subjected to a similar examination in order to secure data for comparative purposes.

The catalase values of the fasting tissues and organs are much lower, in every instance, than those of the normal tissues and organs. It was also observed that the order of the tissues when arranged according to their catalase content is distinctly altered in the fasting animals from the order in force under normal conditions. There is apparently no uniformity as to the specific alterations which take place in the catalase content of animal tissues and organs under the influence of fasting. The data obtained from the four fasting animals under consideration are in every case different from normal catalase values, but at the same time these catalase values obtained from fasting animals exhibit marked variations when we make a comparison of the data from the four animals under investigation. It is of particular

Catalase Values

Dog	Tissue								Days
	Liver	Kidney	Spleen	Lung	Heart	Muscle	Brain	Pancreas	
Normal	67 1	66 4	8 8	7 2	4 3	2 7	0 8	0 7	
Fasting	52 7	50 4	5 1	10 8	2 6	0 0	8 2	0 5	104
Fasting	23 8	4 4	0 0	8 2	0 0	0 0	0 0	0 0	48
Fasting	34 8	46 5	0 0	0 5	0 0	0 0	0 0	0 0	30
Fasting	57 0	11 1		1 2	12 3	0 0	0 0	0,0	7
	Relative Order of Tissue								
Normal	Liver	Kidney	Spleen	Lung	Heart	Muscle	Brain	Pancreas	
Fasting	Liver	Kidney	Lung	Brain	Spleen	Heart	Pancreas		104
Fasting	Liver	Lung	Kidney						48
Fasting	Kidney	Liver	Lung						30
Fasting	Liver	Heart	Kidney	Lung					7

interest that the tissues and organs of the dog which was subjected to the most prolonged period of fasting exhibit less alteration from the normal than do the tissues and organs of those animals which were subjected to much shorter fasts

Demethylation in the Body WILLIAM SALANT and I K PHELPS

Determinations of the urinary purins precipitable by copper sulphate in sodium bisulphide after the administration of caffein indicate that individuals of the same species vary considerably in their power to demethylate this substance The amounts of purin nitrogen obtained from the urine of two dogs when a total of four hundred milligrams caffeine per kilo were given in eight days were eight and thirty two milligrams purin nitrogen per kg After feeding three hundred milligrams caffeine per kilo to these animals during the next four days eight and twenty-two milligrams purin nitrogen per kilo were obtained After an interval of eight days the administration of caffeine was resumed and much greater amounts of purin were found in the urine In one case the amount of purin per kilo was increased two hundred per cent, although the amount of caffeine given was only twenty per cent greater In the other dog the increase of purin nitrogen was sixty per cent greater, the amount of caffeine in this case was likewise increased by twenty per cent It was further observed that demethylation remained relatively unchanged when the caffeine was given daily

Some Experiments on the Influence of the Digestive Process on the Excretion of Carbon Dioxide G O HIGLEY

The apparatus used in this work was the balance-chemograph

The food employed was one half a pound of broiled beef steak at each meal The four subjects were students in the University of Michigan No food was taken by the subject during the five hours preceding an experiment The subject reclined for fifteen minutes, then the "normal" was determined The food was now eaten and fifteen minutes thereafter, and at regular intervals, determinations of the carbon dioxide excretion were made

The maximum increase over the normal was twenty five per cent in one case and only 7 7 per cent in another case

The promptness of the increase was also quite different, the increase over the normal being at the end of thirty minutes, 1 2 per cent, 7 per cent and 11 9 per cent, respectively, in the case of three subjects

The Incompatibility of Alcohol with other Nutrients J E SIEBEL, JR, MD

The incompatibility as subject of this paper refers to a certain incompatibility with nutrients, especially in persons constitutionally affected, which is due to the fact that the human system, having a choice, disposes first of alcohol before other nutrients are affected in metabolism, as proved by the classic feeding experiments of Atwater and confirmed by the author's researches on the electromotive force of nutrients showing a maximum result for alcohol

Accordingly and supported by professional experience, it is concluded that for people constitutionally afflicted with disorders in which, as in arthritis and glycosuria, excesses of proteids and saccharine food are to be avoided, such excesses

are especially harmful in connection with the use of alcoholic beverages, unless special rules of nutrition, given by the author, are followed

Improvements in the Exact Determination of Nitrogen in Feces ISAAC KING PHELPS

The difficulties of an exact aliquot and of loss of nitrogen in drying the viscous material are met by each of two procedures

The first procedure consists in dehydrating the moist mass by treatment with acidified alcohol and ether and filtration The dry residue is then sifted and the nitrogen determined in the residual material, consisting of undigested material, in the powder obtained by sifting (which represents the residue from food) and in the alcohol ether extract

The second procedure consists in partially decomposing the moist material with concentrated sulphuric acid by heating in a steam bath until a *homogeneous mass is produced* This is then aliquoted and the nitrogen determined in the aliquot

The test of accuracy and adaptability of these procedures shows that they are both excellent

The Excretion of Chlorides under the Influence of Copious Water drinking between Meals S A RULON, JR, and P B HAWK

Three experiments were made on the influence of copious water drinking between meals upon the excretion of chlorides The subjects were young men ranging in age from 22 to 29 years Each experiment was divided into three periods, a *preliminary* period during which nitrogen equilibrium was attained through the feeding of a uniform ration of low water content, a *water* period during which the uniform ration was supplemented by the drinking of large volumes of water *between meals*, and a *final* period in which the conditions of the preliminary period were in force

In two of the experiments there was a pronounced increase in the output of chlorides upon the days of added water intake, with a return to normal during the final period This augmented excretion of chlorides is interpreted as indicating that the large volume of water ingested during this period has markedly stimulated the secretion of gastric juice The excess hydrochloric acid thus passed into the intestine has been reabsorbed and appears in the urine as ammonium chloride The main bulk of the increase in the chloride excretion we believe to have originated in this way

In one experiment there was a small increase in the chloride output upon each of the days of increased water ingestion, followed by a pronounced rise in the output upon the first day following the water period Neither the flushing properties of the water nor its stimulatory efficiency as regards protein catabolism or gastric secretion offers a satisfactory explanation for the high chloride concentration observed upon the day following the period of copious water drinking

If we attempt to account for the increased output of chlorides noted during the period of copious water ingestion upon the theory that this increase originated through a stimulated catabolism of protein matter within the organism, we find it possible to account for only two per cent or less of the chloride increase on this basis

In every instance in which a portion of the urine of each day of the water period was collected in four sub periods three and one half hours in length it was observed that the maximum chloride output and urine volume occurred during the second period of the day, *i e*, from 11 30 A M to 3 P M It was also observed that the highest percentage of ingested fluid (84 per cent) was excreted during the periods of copious water intake

Resorption of Fat P F TROWBRIDGE, University of Missouri

A group of seven calves six months old were selected as being of same breed and uniform in size and condition They were fed several months until all were judged to be well fattened and all in about the same condition The one thought to be the least fat was slaughtered and analyzed as a check animal Two of the remaining were held at maintenance of body weight, two were fed so as to lose one half pound per day, and the other two were fed to gain one half pound per day. All were given the same feed, varying only in quantity One of each group was slaughtered and analyzed at the end of six months, the other submaintenance animal at the end of eleven months and the other maintenance animal at the end of twelve months The supermaintenance animal was not slaughtered, as the one half pound per day gain at his age—two years—was sufficient to make him improve in condition

All the maintenance and submaintenance animals lost in fat The long-maintenance animal gained in total protein and also in flesh protein All the animals gained in weight of skeleton from 9 5 per cent. to 16 6 per cent The skeleton of all animals gained in protein, moisture and

ash, and in fat except in that of the long submaintenance animal, which lost over 75 per cent of its original fat The animal on long submaintenance (eleven months) became greatly emaciated and the analysis showed that he had used up nearly all of his reserve store of fat, not only from his flesh, but from his skeleton The short submaintenance animal (six months) and the long maintenance animal (twelve months) had used up nearly all the reserve fat of the tissues, but had not drawn upon the supply in the skeleton

The loss in moisture is not sufficient to correspond to the loss in protein for a lean meat or connective tissue, which supports the view that in certain stages, at least, of fat resorption the fat is in whole or in part replaced by water

The normal skeleton contains about 36 per cent moisture In the long submaintenance animal it has risen to 53 per cent, while the fat content of the skeleton has dropped from 16 per cent to 3 per cent In this time the skeleton has gained nearly one per cent. of its total weight in dry protein The long submaintenance animal lost 10,627 grams in dry protein, but only 24,868 grams in moisture, which lacks about 16 000 grams of being enough to make up the protein loss to lean flesh and connective tissue. During this time the loss in fat was 43,829 grams, or about 90 per cent of the total fat present at the beginning

The Preparation and Properties of an Oxidase occurring in Fruits FIRMAN THOMPSON and HARRY P BASSETT

An oxidase was prepared from the juice of pears and was found to have a marked action in the production of a tannin like substance from gallic acid The extent and rate of this action were measured by the precipitation of the nitrogen in a solution of egg white By this means a very extensive and rapid action of the enzyme was shown Tannin determinations made by one of the standard methods also confirmed these results It was further shown by means of plate cultures that the body thus produced exhibited marked germicidal properties

A gradual decrease of soluble nitrogen in the juices prepared from various fruits indicates that a similar action takes place there on exposure to oxygen of the air The writers consider it doubtful if tannin exists as such in the normal growing fruit, believing it to be rapidly formed on injury or removal from the tree, its function being to inhibit fungous or bacterial growths

Abstracts for the following papers have not been received

"The Iodine Content of a Physiologically Active Substance obtained from the Large, Medium, Small and Mixed Thyroid Glands of Beef, Hogs and Sheep," T B ALDRICH

"The Processing of Japanese Persimmons," H C Gore

"Studies on Lipoid Potassium Compounds of the Tissues," W Koch and C C Todd

"'Normal' Arsenic in the Human Body," R L Emerson

"The Non existence of so called 'Normal Arsenic' in the Human Thyroid Gland," Wm H Warren

"Nutrition Investigations, No 30—Further Improvements in the Methods of Analyzing Flesh," A D Emmett and W E Joseph

"A Method for the Estimation of Reducing Sugars" S R Benedict

"On Luciferesceine, the Fluorescent Material Present in Certain Luminous Insects" (preliminary), F Alex McDermott

"A Note on Fat Synthesis in the Human Intestine," H M Adler

"On the Neutrality Equilibrium in Blood and Protoplasm The Regulatory Activity of the Kidney," L J Henderson

"Chloroform Narcosis and Fatty Degeneration in the Hearts of Nephrectomized Rabbits," F. H McCrudden (with Paul A Lewis).

"Further Studies on the Growth of Plants in Bacterial Transformation Products," A. Dachnowski

"The Relation of Certain Odorous Constituents of Plants to Plant Metabolism," Frank Rabak

"The Influence of Shade on Sugar Accumulation in Tobacco in the Tropics," H H. Hasselbring

"The Chromogen of the Hawaiian Bitter Yam," H H Bartlett

"A Quantitative Method for the Estimation of Oxidases," H H. Bunzel.

"The Alkaloid Content of Ergot and its Fluid Extract," A Seidell

"The Poisonous Properties of the Mushroom *Inocybe infida*," E. D. Clark

"One Rôle of Carbonic Acid in Fermentation," C. H Hudson

"Studies upon the Biochemistry of Penicillium," O. F Black.

"The Action of the Fungus Diplodia upon some Phosphorous Compounds of Maize," A S. Reed.

"The Fermentation of Citric Acid in Milk," A W Bosworth and M J Prucha

"Studies on Thermal Death points of Milk Enzymes," W N Berg

"Studies upon the Extractives of the Maize Embryo," C L Alsberg

"A Rapid Method for the Production of Immune Sera," J P Atkinson

"Plants which Require Sodium," W F V Asterhout

"Inosinic Acid," P A Levene and W A. Jacobs.

"Yeast Nucleic Acid," P A Levene and W A Jacobs

"The Distribution of Nucleanidases in Animal Tissues," P A Levene and F Medigreceau

Dissolved Oxygen as an Index of Pollution GEO A SOPER and PAYNE B PARSONS

The determination of dissolved oxygen as an index of sewage pollution has been found to be reliable in the work of the Metropolitan Sewerage Commission of New York, where the quantities of sewage and conditions attending the discharge of sewage were determined and other factors in the problem known

Opinions differ as to the permissible limit of exhaustion of oxygen by sewage Some authorities consider that more than 30 per cent should not be taken from the water Others have expressed the opinion that 70 per cent was a permissible draft To the present authors it appears that no arbitrary standard can safely be established A careful consideration of the local conditions should determine the safe limit for any case

Abstracts for the following papers have not been received

"Chemical Study of Wheat—Part 2," G B Frankforter and Ben Hur Kepner

"The Composition of some so called Malt-tonics," Julius Hortvet

"The Examination of Beverages for Caffein and other Alkaloids," Edwin DeBarr

"The Soluble Carbohydrates in Asparagus Roots," Fred W Morse

"The Examination of some California Alfalfa," M E Jaffa

"Sugar By-products," Herbert M Shilstone.

"Coffee and Coffee Substitute Extracts," Floyd M Robinson

"The Relative Toxicity of Substances added to and occurring Naturally in Foods," A N Cook

"Quantitative Method for Determining Non-volatile Oil in Cereals," E H Harding and Miss Lilian Nye.

DIVISION OF AGRICULTURAL AND FOOD CHEMISTRY

H E Barnard, *chairman*

B E Curry, *secretary*

Preliminary Report on the Loss of Lime in some Drainage Waters A W BLAIR and S E COLLISON

The paper describes soil investigations involving the use of fertilizers in citrus culture in progress at the Florida Agricultural Experiment Station A description of the large galvanized iron soil tanks in use is given and rainfall records and amount of drainage water collected from the tanks for a period of three months are reported

The lime content of seven samplings of water for the three months is given in parts per million of water, and as pounds of calcium carbonate per acre

Some Poisons in Foods H E BARNARD

A general discussion of the various poisons found in foods as preservatives and as they occur in nature

Determination of Dissolved Oxygen in Water GEO A SOPER and PAYNE B PARSONS

This paper reports an accurate and rapid field method for determining dissolved oxygen in water The oxygen is determined immediately after the sample is taken

The Determination of Arsenic in Insecticides E B HOLLAND

The cooperation of the laboratory with the entomologist in a study of arsenical insecticides necessitated a great many determinations of arsenic This led to a review of the literature on the subject, careful consideration of the various methods offered, and some improvements in the iodine titration method as applied to the analyses of arsenites and arsenates.

Purification of Insoluble Fatty Acids E B HOLLAND

Finding it impossible to purchase insoluble fatty acids of a satisfactory quality, it became necessary to undertake a study of various methods for their purification

The methods that seemed the best adapted for the purpose were (*a*) distillation of the fatty acids in vacuo, (*b*) crystallization from alcohol and (*c*) distillation of the ethyl esters in vacuo, and all were given extended trial

It was found that while saturated fatty acids may be purified by distillation of either the acids or their ethyl esters, the latter method is less hazardous and much easier to manipulate, although more steps are required Crystallization

is a finishing rather than an initial process of purification

Excrement of Guayule fed Animals CHAS P FOX

During time of drought goats feed upon the tender branches of the guayule, *Parthenium argentatum* The leaves of this plant do not contain rubber, but there is a small amount present in the twigs The solid excrement of the guayule-foraging animals does not contain a trace of caoutchouc

Pingue (Colorado rubber weed) is regarded by stockmen as poisonous to sheep In this case death is caused by clogging of the digestive organs with undigested rubber Goats are not affected by guayule

Dissolved Oxygen in New York Harbor GEO A SOPER and PAYNE B PARSONS

The results of an investigation of the sanitary condition of New York harbor with respect to the dissolved oxygen is reported The analyses were made immediately after the samples were taken

The results show that there was not much difference between the amount of oxygen in the water at the surface and at the bottom except that in badly polluted sections the surface samples usually contained rather less oxygen than did the deeper ones This was contrary to expectation and is probably accounted for on the ground that the water was more impure at the top than at the bottom, a supposition supported by the fact that bacteria were most numerous at the top and by the further fact that there was more sea water near the bottom than near the top In comparatively unpolluted sections the deep samples usually contained less oxygen than the surface samples

When the comparatively pure sea water from the lower bay or Long Island Sound entered a polluted section, the amount of oxygen in the water of that section increased by the dilution

Composition of the Ash of Pickles L H S BAILEY.

On account of the use of alum in the hardening of pickles the composition of the ashes of normal pickles as they appear upon the market, and also of pickles in which alum has been used, is of importance For comparison the analyses also of green cucumbers as grown in different localities has been made. A discussion of the importance of the different constituents in the ash and the significance of the presence of these substances follows.

DIVISION OF PHYSICAL AND INORGANIC CHEMISTRY

E C Franklin, *chairman*

S L Bigelow, *secretary*

Apparatus for Measuring Vapor Pressure I H DERBY, F C GUTSCHE and F DANIELS

Two thrice tubulated glass bulbs connected together by a short glass tube are filled with glass pearls and one third filled with liquid The bulbs may be rotated horizontally on the tubes, delivering dry air and conducting away saturated air, respectively, as an axis To each end of this axis a short rubber tube is connected and a short section of glass tubing is placed in each of the free ends of the rubber tubes The rubber tubes are bent down and the short glass tubes fitted loosely over vertical tubes about which they may rotate as axes Mercury contained in a cup surrounding the junction makes a gas tight joint which yet allows rotation of the wider tubes with the bulbs

Important features of the apparatus are (1) simplicity of construction and operation, (2) rapid and complete saturation, (3) saturation at barometric pressure, (4) adaptability to the determination of vapor pressures of solutions and vapor compositions, for which purposes it was primarily designed

The Nature of Mass J E MILLS

The usual idea of mass is made clear It is shown that the modern definition of mass as expressed in the equation, $\frac{1}{2}mv^2 = mas$, is not independent of, but is dependent upon, the attraction of gravitation The attractive forces are compared, and it is shown that there is considerable reason for thinking that mass is a "gravitational charge" Facts bearing upon this suggestion are discussed

Recrystallization of Barium Sulphate H C COOPER and T S FULLER, Syracuse University

By recrystallizing precipitated barium sulphate from molten sodium sulphate at 1150° and dissolving out the sodium sulphate with water they obtained crystals of barium sulphate as long as 5 mm and as wide as 1 mm These crystals correspond to barite, the natural crystallized barium sulphate Equally good crystals of barium sulphate were obtained by recrystallization from molten barium chloride

The Tendency of Chemical Energy Conversion J E SIEBEL, Zymotechnic Institute, Chicago

In connection with the phase and mass law and Chatelier's theorem, the principle of the maximal work as a measure for affinity governs the tendency of chemical energy conversions

The maximal work which is obtainable from a chemical reaction in a reversible cycle is calculable by the second law of thermodynamics, but this law, it is explained, can be more generally expressed by substituting the intensity factor by an equivalent energy factor, in which latter form, as was shown in a former paper, it is more applicable for energy conversion with saturated vapor than the former. It is now shown that the new version is also well adapted to chemical energy conversions, and that it furnishes very simple arithmetic expressions for the solutions of the problems involved.

Nucleation of Mixed Vapors in Dust-free Air: I. H. DERBY.

The expansion ratios necessary to produce, in dust-free air, the formation of rain and fog respectively, in mixed vapors of alcohol and water and mixed vapors of methyl alcohol and water have been determined for each pair of substances at varying concentrations. The series of ratios for each pair of substances show a minimum value for certain mixtures.

A tentative explanation of this behavior rests on the assumption that the molecules of one substance act as nucleation centers for the vapors of the other, due to the fact that the vapors of alcohols are charged with electricity opposite in kind to that found in water vapor.

The Rapid Determination of Silver and Cadmium by Means of the Gauze Cathode and Stationary Anode: R. C. BENNER and W. H. ROSS.

The study of the efficiency of the gauze electrode with a stationary anode as a rapid means for the deposition of the metals was extended to include silver and cadmium. Satisfactory results were obtained for each metal by using an electrolyte consisting of potassium cyanide in a potassium hydroxide solution. White adherent deposits were uniformly obtained in this manner. Good results, however, were not obtained when using any of the electrolytes commonly recommended for the older electrolytic methods.

The Rapid Deposition of Cobalt and Nickel by Means of the Gauze Cathode and Stationary Anode: R. C. BENNER and W. H. ROSS.

A study was made of the efficiency of the gauze electrode as a rapid means of depositing the metals nickel and cobalt with currents of from three to four amperes. Excellent results were obtained for each metal with the following electrolytes which were used in the older electrolytic methods—ammonium sulphate, ammonium acetate and ammonium formate, all in ammoniacal solution. In a neutral or slightly acid solution there is a tendency to anodic deposition. The results obtained with ammonium oxalate were not quite as satisfactory as with the other electrolytes named. A number of determinations were made in solutions of ammonium carbonate. This formed a most satisfactory electrolyte, either with or without the addition of ammonium hydroxide, from which to deposit these metals.

The rate at which these elements are precipitated on the gauze electrode is practically the same for all electrolytes mentioned, and, although not quite equal to the rate at which they can be precipitated when the electrolyte is agitated by mechanical means, is rapid enough for practical purposes. This method is likewise much more satisfactory because of the simplicity of the apparatus and from the fact that, if desired, the older methods with small currents may be used with the same electrodes.

The Function of the Walls in Capillary Phenomena: S. L. BIGELOW and F. W. HUNTER.

Experimental method and results were given demonstrating that the capillary ascension of water is measurably different in tubes of Zn, Cu, Ni, Al, Ag, Pt, glass, celluloid, beeswax and paraffin. From this fact the conclusion was drawn that, in all cases except where the maximum ascension is obtained, the ascension is a measure of the adhesion between the liquid and the walls rather than a measure of the cohesion (surface tension) of the liquid.

The capillary ascensions of saturated solutions of copper sulphate, gypsum, sodium chloride, potassium dichromate and alum were measured in tubes of platinum, of glass and of the solid solute. A regularity was discovered which may be stated as follows: The adhesion between a salt and its saturated solution is nearly the same for a number of salts irrespective of their chemical nature. The paper will appear in the *Journal of Physical Chemistry*.

The Hydrocarbons in Lignite: G. B. FRANKFORTER and A. P. PETERSON.

In this paper the hydrocarbons have been studied with the idea of isolating some of the heavier ones. The first work consisted in the proximate analyses of the lignites from the various localities, ranging from the southern to the extreme northern limits of the Dakota, Saskatchewan, Alberta and Alaska lignite belts.

An average of the distillation products in these different samples was about 50 per cent. carbon

residue, 1 to 5 per cent of tar, 25–35 of condensed water The gaseous products ranged from 15 to 25 liters per 100 grams of coal The gaseous products were characterized by the very large amount of carbon dioxide they contained It varied from 20 to 40 per cent, depending upon the locality of the lignite There was an increase of hydrocarbons and a decrease of carbon dioxide in the gases from the lignites passing from south to north The samples likewise resembled bituminous coal more closely from south to north

Snow as a Means of Studying the Smoke Nuisance Geo B Frankforter

In this paper snow has been used as a means of determining these constituents After the snow had covered the ground for a given time, the amount on a square foot of ground was collected, melted and the solid matter filtered off and weighed The solids were analyzed and finally the water was examined for the soluble solids and gases

The amount of solid matter which fell during six weeks of winter weather in the cities of Minneapolis and St Paul varied from 3 to 2 69 grams per square foot within the city limits An average of ten analyses gave 1 43 grams per square foot Calculated on the basis of one gram per square foot, there would be 43 56 kilograms per acre or 27 8 tons per square mile

An average of ten analyses gave 57 16 per cent. of carbon and 42 84 per cent of ash

Average of ten analyses of the ash gave the following

SiO_2	50 50
Ca	1 13
Mg	0 31
Fe	12 10
Al	14 26
Alkalies	1 70

The snow water was then analyzed and found to contain a considerable amount of soluble matter

An average of ten analyses gave the following

	Parts per Million
Total solids	39 5
Chlorine	5 1
Free ammonia	0 26
Nitrites	0 038
Organic matter (oxygen consumed)	2 49
SO_4	4 84

A New Indicator. Chas P Fox

The bark of a Congo rubber producing vine, said to be one of the *Landolphias*, gives an aqueous extract which exhibits the properties of an indicator. Alkalies give a deep red (magenta), acids, a light yellow to colorless Change is sharp enough for use in technical work. The aqueous preparation is unstable The coloring substance is precipitated by acids

A Quantitative Expression of the Periodic Classification of the Elements. Frederick G Jackson

A chart was shown on which the atomic weights of the elements were plotted, the members of each small period being plotted on equidistant abscissæ, and an increasing multiple of 22 being subtracted from the atomic weights The principal families of the elements were shown by connecting their members by lines From these lines it was graphically shown that the values at present assigned to A and Te are three or four units too great, and it was suggested that Se may also be too high Other interesting relations were indicated between different family lines

A Simple Hydrogen Sulfide Generator J I D Hinds, University of Nashville, Nashville, Tenn

The apparatus is in one piece The acid is added drop by drop to the sulfid and when the stopcock in the delivery tube is closed the acid is driven immediately away from the sulfid and action ceases Advantages (1) the quantity of acid in generator is always small, (2) if the acid is properly added it is practically exhausted when it passes out, (3) it is cheap, economical, no waste of gas, (4) it empties itself whenever the gas is cut off, (5) the waste flows away automatically to the sink or the open air, (6) it is always ready and may be carried from place to place

Sulfite Method for Separating and Identifying Strontium and Calcium · J I D. Hinds

Principle—Barium sulfite is difficultly soluble in hydrochloric acid, strontium sulfite is difficultly soluble in acetic acid, calcium sulfite is easily soluble in both acids

1 To a small portion of the solution (1 or 2 c c) add a drop of dilute hydrochloric acid, then a few drops of a concentrated solution of sodium sulfite A white precipitate is barium sulfite and indicates barium

2 To another small portion of the solution add a little dilute acetic acid and a few drops of sodium sulfite solution and heat to boiling A white precipitate is barium sulfite or strontium sulfite or both. In the absence of barium, it can

only be strontium. If barium is present, it should first be removed with chromate ion.

3. If barium and strontium are absent, precipitate calcium with the sulfite without acid.

4. If strontium and calcium are present together, there are two methods of procedure.

(*a*) Add to a portion of the solution sodium sulfite and warm gently, not above 30°, shake well and filter. The calcium is almost completely precipitated while much of the strontium remains in solution. Boil a portion of the filtrate. The remaining strontium separates. If strontium is absent there is no precipitate or at least a faint cloud. Pour over the precipitate on the filter a very dilute solution of acetic acid and to the filtrate add ammonium oxalate. A precipitate is calcium oxalate.

(*b*) Make the solution acid with acetic acid, add sodium sulfite and boil. Be sure that acid is added in excess of that required to neutralize the sulfite solution which is alkalin by hydrolysis. The mixture should be but slightly acid. Shake well. Let stand a few minutes to settle, then filter, pouring the liquid through repeatedly until it is clear. Dilute a portion of the filtrate with an equal quantity of water and add ammonium oxalate. A precipitate is calcium oxalate.

DIVISION OF PHYSICAL AND INORGANIC CHEMISTRY

Electrical Equipment for Electroanalysis and Electric Furnace Work: FRANCIS C. FRARY.

The author described specially designed switchboards for the distribution of the current from a storage battery to a class in electroanalysis, and for the use of the individual students in the class. The boards are designed from the view point of maximum efficiency and flexibility at minimum expense.

The arrangement of a 10 K.V.A. transformer for work in the furnace-room was described and illustrated. Four secondary coils are provided, two giving 10 volts and two 20. By means of copper straps these may be connected in all possible useful combinations. Five and 10 per cent. taps on the high tension (220 volt) side of the transformer allow the increase or decrease of the voltage thus generated by 5 or 10 per cent., thus giving four possible voltages for each combination of the secondary coils. Suitable circuit-breakers are provided on both the primary and secondary sides of the transformer. Suitable measuring instruments are provided, and a large double throw double pole switch allows the bus bars in the furnace-room to be connected to either direct or alternating current.

Abstracts for the following papers have not been received:

"Electric Osmose," Harry N. Holmes.

"The Effect of Continued Grinding on Water of Crystallization," Nicholas Knight.

"The Determination of Manganese by the Sodium Bismuthate Method," M. H. P. Brinton.

"The Sulfur Hydrosol Prepared by a New Method," Harrison Everett Ashley.

"The Dielectric Capacity of some Liquid Hydrides," R. C. Palmer and Herman Schlundt.

"A Case of Ammonia Deliquescence," W. P. Bradley.

"The Action of Ammonia upon Ammonium Sulfocyanide," W. P. Bradley.

"On the Electrochemical Oxidation of Hydrazine," J. W. Turrentine and Willis A. Gibbons.

"Contribution to the Electrochemistry of Hydronitric Acid: the Electrochemical Corrosion of some Metals in Sodium Trinitride Solution," J. W. Turrentine.

"Experiments on the Reliability of the Borax Bead Test for Varying Mixtures of Nickel and Cobalt," P. Rothberg and L. J. Curtman.

"A Study of the Factors Influencing the Systematic Qualitative Determination of Barium," E. Frankel and L. J. Curtman.

"Rapid Electrolytic Deposition of Metals from Boiling Solutions," Franz F. Exner.

"The Pocket Spectroscope—A Neglected Necessity for the Practical Chemist," Chas. S. Palmer.

"Physical Properties of Aqueous Solutions containing Ammonia and Citric Acid," Robert A. Hall and James M. Bell.

"The Action of Hydrogen Sulfide on certain Metallic Salts in Non-aqueous Solvents," W. G. Wilcox.

"The Heat of Neutralization of Pyridine in Various Solvents," J. Howard Mathews.

"The Use of a Dewar Flask in Measurements of Heats of Neutralization," J. Howard Mathews and A. F. O. Germann.

"Surface Tension Measurements at the Surface between two Liquids," W. D. Harkins.

"Equilibrium in the System Lead Nitrate Pyridine," J. H. Walton, Jr., and R. C. Judd.

"The Action of Oxides of Lead on Normal Potassium Tartrate," F. C. Krauskopf.

"On the Interaction of Metallic Sodium and Mercury," L. Kahlenberg and David Klein.

"The Vapor Pressure of Dried Calomel," Alexander Smith and A. W. C. Menzies.

"The Vapor Pressures of Sulfur," Allan W. C. Menzies.

"A Lower Limit for the Critical Temperature of Mercury," Allan W. C Menzies

"The Diffusion of Oxygen through Solids," G B Frankforter and R S Callaway

"On the Mechanism of the Reactions of Alkyl Halides with Sodium Ethylate and with Sodium Phenolate," S F Acree, H. C Robertson and E K Marshall.

"The Effect of certain Neutral Salts on the Hydrolysis of Ethyl Acetate at 100°," W E Henderson and D R Kellogg

"The Violet Coloration of Ferric Alums and Nitrate," W E Henderson

"Electrical Equipment for Electroanalysis and Electric Furnace Work," F C Frary

"The Fluorescence of Anthracene," Wilder D Bancroft.

"Chemical Properties of certain Radioactive Substances," B B Boltwood

"Equilibrium in Carbonate Solutions," Herbert N McCoy

"Radioactivity of Thorium Products," Herbert N McCoy

"Is the Action of the Enzyme Invertase Reversible?" C S Hudson and H S Paine

DIVISION OF INDUSTRIAL CHEMISTS AND CHEMICAL ENGINEERS

A D Little, *chairman*

F E Gallagher, *secretary*

Platinum Laboratory Utensils PERCY H WALKER F W. SMITHER

The article calls attention to the fact that a great deal of platinum ware, such as crucibles, dishes, etc, offered for sale at the present time is of inferior quality, some of it being absolutely unfit for use in a laboratory

Methods of testing platinum laboratory apparatus are described, and suggestions for a standard specification for such ware are given

Solubility of Oxygen in Sea Water GEORGE C WHIPPLE and MELVILLE C. WHIPPLE

Temperature °C	Distilled Water (Committee on Standard Methods of Water Analysis)	Dissolved Oxygen in Milligrams per Liter				
		Chlorine, 0	Chlorine, 5,000	Chlorine, 10,000	Chlorine, 15,000	Chlorine, 20,000
0°	14.70	14.62	13.79	12.97	12.14	11.32
5	12.80	12.80	12.09	11.39	10.70	10.01
10	11.31	11.33	10.73	10.13	9.55	8.98
15	10.14	10.15	9.65	9.14	8.63	8.14
20	9.19	9.17	8.73	8.30	7.86	7.42
25	8.35	8.38	7.56	7.96	7.15	6.74
30	7.60	7.68	6.86	7.25	6.49	6.13

Solubility of Oxygen at Different Temperatures in Water containing Different Amounts of Chlorine

From original experiments made with the Winkler method and experiments by Fox, using a method of direct absorption, a table has been prepared showing the solubility of oxygen at different temperatures in sea water and brackish waters containing different amounts of chlorine The results in condensed form are given above

The Work of the Chemical Laboratories of the Bureau of Mines J K CLEMENT

The chemical work is divided among a number of separate laboratories, each carrying on its own lines of work under the direction of its own chief, the whole forming a group of more or less independent units In general, the problems of the chemists are closely connected with those of the mining and mechanical engineers

The Fuel testing Laboratory is occupied mainly with the analysis and calorimetric testing of fuels, including coal, coke, lignite and peat In addition to analyzing samples of all fuels used in the boiler and gas producer tests of the bureau, ultimate analyses and calorific value determinations are made on mine samples of coal collected by the U S Geological Survey, as well as by certain state geological surveys

Fusibility and Clinkering of Coal Ash—In the use of coal under steam boilers, the property next in importance to its calorific value is perhaps the fusibility of its ash Indeed, some coals, which have a high heating value, are worthless for making steam on account of their tendency to clinker and adhere to the grate bars The relation between the fusibility and clinkering properties of coal ash and its chemical and mineralogical composition is now being investigated

Chemistry of Petroleum Technology—The bureau is making a study of the commercial bodies contained in the crude petroleums of the United States, of the methods for their separation and purification and of their economic uses The California fields have been selected for first study

Combustion Investigations—The processes of combustion in the boiler furnaces are being investigated in a furnace specially designed for the purpose.

The process of producer-gas formation is being studied from a physical chemical standpoint, and an attempt will be made to apply, on a commercial scale, the results of laboratory experiments on the rate of formation of carbon monoxide and water gas.

The Composition of Coal.—The object of this investigation of the bureau is the isolation and identification of some of the constituents of coal.

The Volatile Matter of Coal.—The quantity and composition of the gases evolved from various coals, when heated to temperatures of from 400° to 1000° C., have been determined. In the experiments which are now in progress, particular attention will be given to the influence of the rate of heating on the character of the gases produced, to the initial composition of the gases at the instant of liberation, and to the thermal decomposition of these gases during passage over heated surfaces.

Weathering and Deterioration of Coal.—In cooperation with the Navy Department, the Panama Railroad Company and the University of Michigan, the bureau is conducting an extensive series of tests on the deterioration of various coals in storage both in the open air and when submerged in fresh water and sea water.

The Accumulation of Gas from Coal.—The quantity and rate of formation of inflammable gas from freshly mined coal, at ordinary temperatures, and the rate of absorption of oxygen by the coal have been determined.

The spontaneous combustion of coal is being investigated by the bureau. Statistical information will be combined with the results obtained in the laboratory.

The Burning of Coal in Mines under a Diminished Supply of Oxygen.—The factors governing the propagation or extinguishing of fires in mines are being investigated.

Examination of Mine Gases.—Examination is made of samples from normal mine air, from the after damp following explosions, from stagnant areas and from burning areas during mine fires. Particular attention has been given to the detection of small amounts of carbon monoxide.

The Chemistry of Explosives.—Chemical analyses are made of all explosives submitted to the bureau for test, of the products of combustion of explosives, and of electric detonators, blasting caps and fuses.

Coal dust Explosions.—The two greatest sources of danger encountered in mining operations are the explosive gases given off by the coal, and the finely divided coal dust which exists throughout most coal mines. The first danger can be overcome by increasing the ventilation in the mines. Unfortunately, this increases the danger from the coal dust by the removal of its moisture.

Abstracts for the following papers have not been received:

"An Improved Process for Finishing Beef Extract," J. T. Donald.

"Self recording Efficiency," A. D. Smith.

"Efficiency in Acid Phosphate Manufacture," F. B. Porter.

"Chemistry as a Factor in Foundry Efficiency," Walter P. Schuck.

"Note on the Utilization of Lumber Waste," Jas. C. Lawrence.

"The Use of Peroxide for Silk Bleaching," W. S. Williams.

"Economical Steam Generation," C. F. Wood.

"The Importance of Eliminating Air Leaks in the Manufacture of Sulfite Acid," C. M. Ballard.

"The Spontaneous Combustion of Coal," S. W. Parr and F. W. Kressman. (Illustrated by lantern.)

"The Modern Manufacture of Portland Cement from the Chemical and Mechanical Standpoint," George P. Dieckmann. (Illustrated by lantern.)

"Errors in Determining the Sizes of Grain of Minerals and the Use of Surface Factors," Harrison E. Ashley and Warren R. Emley.

"The Utilization of Smelter Smoke in Preparing Sulfates from Clays," Harrison Everett Ashley.

"The Determination of Water in Mixed Paints," G. A. Abbott.

"Linseed Oil," A. H. Sabin.

"A Modified Process for Cane-sugar Manufacture," Harry McCormack.

"Notes on the Production and Composition of Mexican Pulque and Mescal," H. W. Rohde.

"The Importance of a Standard Temperature for Specific Gravity determinations and for Standardizing Standard Measurings," G. W. Thompson.

"Soaps from Different Glycerides—Their Germicidal and Insecticidal Values in Themselves and when Mixed with Active Agents," H. C. Hamilton.

"Experiments on the Corrosion of Iron," W. D. Richardson.

"The Determination of Moisture in Coal," John White.

"The Disintegration of Concrete in Septic Tanks," Wm. M. Barr.

"Tensile Strength of Hair Cloth," Chas. P. Fox.

"The Exact Electrolytic Assay of Refined Copper—(1) Standard Method, (2) In Solenoid with Revolving Electrolyte," Geo. L. Heath.

"The Determination of Arsenic and Antimony in Copper, including a New Rapid Volumetric Method," Geo. L. Heath.

DIVISION OF ORGANIC CHEMISTRY

E C Franklin, *chairman*
Ralph H McKee, *secretary*

No abstracts have been received

"The Oxidation of Styrolene Alcohol," Wm L Evans and Lou Helen Morgan

"The Oxidation of Propylene Alcohol," Wm L. Evans and Edgar Witzemann

"The Action of Ethylates on Nitrites," S F Acree and E K Marshall

"Some Ketoester Addition Products," Richard S Curtiss, L F Nickel and R H Lewis

"On the Colored Salts of Nitromalonic and Dinitroacetic Esters," Richard S Curtiss and John A Kostalek

"The Action of the Derivatives of Tolylhydrazines on Quinones," Wm McPherson and George W Stratton

"An Important Method for the Preparation of Orthohydroxyazo Compounds," Wm McPherson and Cecil Boord

"Para Brom Phenyl Isoureas," Robert A Hall

"The Constitutions of Fucose and Rhodeose," C S Hudson

"The Constitution of Dehydracetic Acid," Wm J Hale

"Amine Salts of Organic Acids," J Bishop Tingle and T E Layng

"Organic Arsenic and Antimony Compounds," J Bishop Tingle and K Clark

"The Action of Alcoholic Ammonia on *ab*-Dibromproprionic Acid," Wm H Warren

"Tribromtertiary Butyl Alcohol," T B Aldrich.

"On the Constitution of the Salts of Acridine and its Derivatives," L H Cone

"The Hydrocarbons in the Various Forms of Lignite," G B Frankforter and Andrew P Peterson

"The Polymerization of the Pinenes," G. B. Frankforter and Frederick Poppe

CHEMICAL EDUCATION SECTION

C F. Burgess, *chairman*

The Use of the Blue-print in the Teaching of Industrial Chemistry FRANCIS C FRARY

Instead of the time-honored methods of showing charts or drawing diagrams of machinery on the black-board, the author recommends the use of the lantern slide and the blue-print the lantern-slide to be shown to the class, and a blue-print of the apparatus, made from the same negative as the slide, to be given to the student to paste in his note-book. Thus time is saved in the class-room, and the student has a better idea of the apparatus. The system was developed by Dean W R Appleby, of the Minnesota School of Mines, for use in the teaching of metallurgy, and the author has found it likewise helpful in the teaching of industrial chemistry and electrochemistry

Proficiency in Qualitative Analysis H C COOPER

The results of an inquiry among prominent American chemists conducted to ascertain how students can best be prepared to make reliable analyses of miscellaneous materials were reported It was the majority opinion that the students should be given rather extensive drill in the thorough qualitative analysis of minerals and technical products Since qualitative analysis is generally taught to freshmen or sophomores, praiseworthy mention was given to the plan of conducting a supplementary course in the subject for the advanced students Considerable discussion was aroused by the question of teaching students to make abbreviated analyses

Points of View in the Teaching of Industrial Chemistry JAMES R WITHROW

Defining industrial chemistry as the study of the manufacture of chemical substances and the production of commercial products with the help of chemical operations the point of view of the lecture work was taken up Each industry is considered as a problem for the solution of the difficulties of which much work has been done and much remains to be done The student is also made to analyze each of the industries with reference to operations involved, such as distillation, condensation, filtration, etc These points of view give the student the desirable attitude of mind which makes him analytically critical of the industries and also makes him scrutinize the methods used to overcome difficulties in a way that makes for increased personal efficiency With regard to the laboratory work, the usefulness of familiarizing the student with the "tools of the trade" is emphasized, but the mere requirement of such familiarity is by no means the highest object to be obtained Emphasis is laid rather on the solution of problems in the study of cost and acquiring of data for use in works experiments on the manufacture of commercial products or utilization of by-products The difficulties arising give the student a keen appreciation of the value to him of the library and all work, whether theoretical or practical, which is within his reach In a word, the work is industrial research. It shows the student how to attack problems; familiarizes him with the spirit of manufacturing chemistry, gives him the proper attitude of mind toward his science, makes him

appreciative of the labor of others, and makes him conscious of the meaning of the responsibility of industrial service

Abstracts for the following papers have not been received

"A Laboratory Course in Chemical Engineering," W H Walker and Wm K Lewis

"The Preparation of 'Known' Solutions in Qualitative Analysis," L J Curtman

"Instruction in Physical Chemistry—Two Modifications," R Stevenson

"Suggestions as to Certain Desirable Changes in Chemical Nomenclature," Edwin Booth

"Quantitative Analysis as a Science," W D Harkins

DIVISION OF FERTILIZER CHEMISTRY

F B Carpenter, *chairman*

J. E Breckenridge, *secretary*

The Determination of Nitrogen in Commercial Ammoniates of High Nitrogen Content Report of the Committee on Nitrogen, Division of Fertilizer Chemists PAUL RUDNICK, chairman

Three samples were prepared, namely, dried blood, tankage and a complete fertilizer, all the nitrogen of which was derived from the same lot of dried blood Forty eight laboratories reported results by all the usual methods, including an average of 223 individual moisture determinations and 259 individual nitrogen determinations on each of the three samples

The results were grouped into tables according to the methods employed The results by the absolute or cupridoxid method were unsatisfactory and only one set of determinations by the soda lime method was received

The individual variations from the arithmetical means in the several tables were large, but the average results of the "wet combustion" methods showed a very satisfactory agreement

The Kjeldahl Gunning method gave the highest results

Special attention is called to the necessity for special precautions in the preparation and packing of samples representing shipments of these and similar commodities, in order that changes in the moisture content may be reduced to a minimum

Abstracts for the following papers have not been received

"The Results of Soil Investigations as Affecting the Use of Fertilizers," F B Carpenter

"The Growth that Forms in Neutral Ammonium Citrate," Robert A Hall

"What Allowance should be made for Variation in Guarantee and Analysis of Fertilizer, and what, if any, Credit should be given a Manufacturer for an Excess in one or more of the Ingredients, to Offset a Deficiency in Another," R E Rose

"Some Causes affecting the Accuracy of the Kjeldahl and Gunning Methods for the Determination of Nitrogen," Ray Henry

"A Bacteriological Method for Determining Available Organic Nitrogen," J M McCandless

"Uniform Rules and Regulations for the Admission of Ammoniates throughout the Southern States," J M McCandless

"Availability of Organic Nitrogen," J E Breckenridge

"The Use of Nitrate of Soda in Commercial Fertilizer," Charles S Cathcart

G A Farnham reported for the Committee on Phosphoric Acid

J E Breckenridge reported for the Committee on Potash

C. F Hagedorn reported for the Committee on Phosphate Rock

DIVISION OF PHARMACEUTICAL CHEMISTRY

A B Stevens, *chairman*

B L Murray, *secretary*

No abstracts were received from this division

"Citro-compounds of Iron," A B Stevens

"Pharmacopœial Standardization," A B Stevens

"Does Oil of Sassafras contain Camphor?" Emerson R Miller and G H Marsh

"Assay of Gelsemium Root," L E Sayre

B E CURRY

DURHAM, N H

THE CHICAGO ACADEMY OF SCIENCES

THE annual meeting of the Chicago Academy of Sciences was held January 10, 1911, at which time Dr T C Chamberlin was reelected president; Mr A. L Stevenson, first vice president; Dr U S Grant, second vice president, and Dr Wallace W. Atwood was again made secretary The reports of the officers of the academy showed that during the past year the work and the influence of the academy have become more strongly educational The scientific collections and exhibits in the museum are carefully maintained and will always be available for specialists to study, but the museum is rapidly taking on a distinctly educational policy and the exhibits are being appropriately altered or replaced

The loaning of museum material to the schools has continued, lecture courses or lessons have been offered to the children who have come as delegates from their respective school rooms, several illustrated lectures have been given at the schools, instructional courses open to the teachers of nature study have been offered and university credit courses have been conducted for those wishing to systematically pursue courses of instruction

It is evident from the work, both of the museum and of the instructional courses given in cooperation with the work of the museum, that the academy is rapidly assuming a conspicuous place among the educational institutions of Chicago The expressions of appreciation which have come to us from the superintendent and district superintendents of the public schools have been most encouraging The expressions of appreciation which reach us from the principals and teachers more immediately engaged in the educational work of the North Side, are enthusiastic in praise and appreciation of the influence which the academy is having

The opportunities for the academy lie far beyond anything which we have yet realized The North Side of Chicago is distinctly lacking in any public institution which is actively assisting in the educational work of the schools and offering instructional courses for adults. The work of the academy should be consistently restricted to the utilization of the scientific data and material in educational work, but the opportunities within that field are among the most attractive that are open to any educational workers

It is, indeed, somewhat surprising to see how easily the academy may become an effective instrument in the educational work of the city There seem to have been so many gaps, so many places where we may fit in, and the regret is that we have not better facilities at the building and a larger force who may put their personal efforts into the promotion of science work among the young people and teachers of the city.

The institution has outgrown its present quarters and the demands upon it and the opportunities open to it indicate that the additional building which was originally planned for the institution should now be erected We need a new building with an auditorium which has a seating capacity of five to eight hundred for various meetings and lectures Class rooms, laboratories and children's work rooms in which courses of instruction may be conducted, should be provided and a children's museum should be placed in this additional space

WALLACE W ATWOOD,
Secretary

SOCIETIES AND ACADEMIES

THE PHILOSOPHICAL SOCIETY OF WASHINGTON

THE 688th meeting of the society was held on January 28, 1911, President Day in the chair Three papers were read

Integers Useful in Computing Square Roots of Numbers DR R S WOODWARD, of Carnegie Institution of Washington

This paper is a continuation and extension in application of the paper on "A Method of Precision for Computing Square Roots of Numbers," presented by the speaker at the 680th meeting of the society This paper will later appear in full in the publications of the American Mathematical Society

A Method for Grading the Results of Tests in Judging DR LYMAN J BRIGGS, of the Department of Agriculture

This paper describes a rational method of grading student tests in judging such as are now extensively held in agricultural schools These tests consist in determining how nearly five or more objects can be arranged in the correct order of excellence Since adjacent objects, when the series is correctly arranged, differ in excellence in varying degree, it becomes necessary to take cognizance of this in grading the arrangements made by different students Furthermore, since there are seven hundred and twenty possible arrangements of six objects, the grading of the different arrangements becomes hopelessly complicated unless some rational system is adopted

The system proposed is based upon the three following principles

1 Any arrangement of objects departing from the correct order is brought about through the exchange of adjacent objects

2 The error due to transposing two adjacent objects from their correct order is directly proportional to the difference in excellence of the two objects transposed.

3 An erroneous arrangement is penalized in the exact proportion that the error bears to the greatest error that can be made in the series under consideration

In employing this system of grading the instructor first decides upon the relative difference in excellence between adjacent objects in the

series when arranged in correct order This virtually amounts to distributing the objects properly along some numerical scale taken as a scale of excellence Each student's arrangement of the objects is then penalized in proportion to the difference in excellence of the objects exchanged and to the number of exchanges necessary to bring about the correct arrangement The penalty can be placed upon a percentage basis, if desired, by determining the ratio of any observed errors to that represented by completely inverting the series The system can be applied to any series either with uniform or non uniform intervals, it requires no tables, and it can be used with any number of objects

The Measurement of Two Primary Base Lines with Invar Tapes Mr WILLIAM BOWIE, of the Coast and Geodetic Survey

There are several types of base apparatus which have been used successfully in recent years by the Coast and Geodetic Survey They are (1) the secondary apparatus, a monometallic multiple bar system, (2) the duplex apparatus, a bimetallic multiple bar system, (3) steel tapes of 50 and 100 meters in length, and (4) nickel steel or invar tapes of 50 meter lengths

The secondary bars and the duplex bars gave very accurate results, yet their operation was more expensive than tapes Tests made at the Holton base in 1891, by Professor R S Woodward, indicated that primary base lines could be successfully measured with steel tapes, and they were used in connection with the duplex bars in 1900 in the measurement of nine bases along the 98th meridian In 1906 six primary bases were measured with both steel and invar tapes It was found that the measurement of a base with tapes occupied about twenty days while the measurement of a base with the bars had usually taken several months

As the nickel steel or invar base tapes were satisfactory in the measurement of bases in 1906 it was decided to use them in measuring two primary bases, one at Stanton, Tex, and the other at Deming, N M, on the Texas California arc of primary triangulation in 1909–10 These bases were measured by the triangulation party working in the vicinity Owing to the small coefficient of expansion of the invar metal, it is possible to do the measuring in the hours of daylight The coefficient of expansion of the tapes used on the primary bases by the Coast and Geodetic Survey is only about one twenty-fifth that of steel

Four invar tapes, each 50 meters in length, were carried to the field and three of them were used in the measurement One was held in reserve for use in case of accident to one of the other three The tapes were standardized at the Bureau of Standards before and after the measurement of each base The Stanton base has a length of 13,193 meters The size of the party on this base was two observers and seven other men One of the observers was Mr J S Hill, the chief of party During the actual measurements only six persons were engaged

A very simple tape stretcher was used on the measurements of the Stanton and Deming bases, its weight being only eighteen pounds The adoption of this simple and light stretcher is a step in the right direction, for the amount of measuring accomplished by a party in any one day depends largely upon the endurance of the man carrying the forward stretcher

A base 15,554 meters in length was measured in the vicinity of Deming, N M, in 1910, by the same party that measured the Stanton base in the previous year The measurement of the Stanton base occupied the party seventeen days, while thirteen days were required for the measurement of the Deming base The probable error of the measurement of the Stanton base was one part in 2,560,000, and the probable error for the Deming base was one part in 1,960,000

Some of the conclusions which were drawn from the measurement of these two bases are (1) the 50 meter tape was found to be both convenient and satisfactory, confirming the conclusions based upon previous tape work by the Coast and Geodetic Survey, (2) invar tapes with measurements made in daylight or at night give results which are as accurate as those obtained by the duplex base bars; (3) it is not necessary to standardize the invar tapes in the field; (4) owing to their small coefficients of expansion invar tapes give more accurate results than steel tapes, (5) with proper care during measurements in the field, the invar tape does not change appreciably in length While not so elastic as steel, yet it is sufficiently strong to withstand the ordinary shocks due to excessive tension

It is possible that the invar tape will not find favor with the surveyor and engineer, for general use, on account of its low elasticity, but it has proved to be a most satisfactory apparatus for the measurement of primary base lines by the Coast and Geodetic Survey.

R. L. FARIS,
Secretary

THE GEOLOGICAL SOCIETY OF WASHINGTON

THE 237th meeting of the society was held at the Cosmos Club on Wednesday evening, January 11, 1911

Regular Program

Desert Pavements and Analogous Phenomena E E FREE

Where wind scour acts on unconsolidated desert materials pebble pavements are of common occurrence Such occurrences have been described by Blake,[1] Tolman[2] and others As a result of similar wind scour the surface sand of stable dune areas is often coarser than that underneath Analogous pavements are occasionally produced by water action

Nonnezoshe—the great Natural Bridge of Southern Utah JOSEPH E POGUE

Southeastern Utah boasts four natural bridges, the Owochomo, the Kachina, the Sipapu and Barohoini (Piute for rainbow) or Nonnezoshie (Navaho for stone arch), each of which surpasses in size the well known Virginia natural bridge The first three of these have been called by commonplace personal names, but the above names are original Indian ones and are far preferable The largest and most southerly of the four, the Rainbow Bridge, was visited on July 26, 1910, by a U S Geological Survey party consisting of H E Gregory, in charge, John Wetherell, K C Heald and the writer This imposing structure is situated in San Juan County, in a wild and well nigh inaccessible part of the Navaho Reservation, just four miles north of Navaho Mountain and near the junction of the San Juan and Colorado rivers

The La Plata (Jurassic?) sandstone, here 1,200 feet or more in thickness, is deeply dissected by a labyrinth of tortuous canyons, and near the mouth of one of these the bridge is found A towering arch, rainbow-shaped and of model symmetry, rises from a ledge on one side of the canyon, and spanning a small stream, joins the opposite wall on its downward bend The opening measures 267 feet in height by 278 feet between abutments, but the distance from stream bottom to top of arch totals 309 feet, while the keystone portion is only 42 feet thick by 33 feet wide The arch is carved from a buff colored massive phase of the La Plata sandstone, and represents an opening, enlarged and shaped by desert weathering, through which the stream originally cut off one of its meanders The abandoned meander remains as a proof of this origin

The bridge was discovered on August 14, 1909, by W B Douglas, of the U S General Land Office, with four assistants, and Byron Cummings, of the University of Utah, with three students, under the guidance of John Wetherell and two Navaho Indians It has subsequently been set aside as a national monument and represents the largest and most graceful structure of its kind thus far known

Criteria for an Unconformity in the so called Laramie of the Raton Mesa Coal Fields of New Mexico and Colorado W T LEE

During the summer of 1910 the unconformity in the coal bearing rocks of the Raton coal field of New Mexico, first announced in 1908 and published upon the following year, was traced around the Raton coal field in New Mexico and the Trinidad coal field in Colorado, an area extending about ninety miles along the east front of the Rocky Mountains and stretching eastward to a maximum width of fifty miles The evidences of unconformity may be grouped under two general headings, stratigraphic and paleontologic

The formation below the unconformity is coal-bearing and varies in thickness from about 450 feet to 0 The formation above the unconformity is likewise coal bearing and is marked by a constant basal zone of conglomeratic sandstone The relation of the basal conglomerate of the upper formation to the beds below leaves little room for doubt that the variation in thickness of the lower formation is due to erosion In at least four places the lower coal bearing formation is wanting and the basal conglomerate of the upper one rests upon older rocks This basal conglomerate contains pebbles of coal which must have come from the lower coal formation, pebbles of conglomerate which could come only from the Dakota, stratigraphically about 3,500 feet below, or from some formation still older, pebbles of red sandstone which could come only from the red beds, the top of which is about 4,000 feet below, pebbles of horn corals and fossiliferous cherts, such as are now found in the Carboniferous rocks west of the coal fields, about 18,000 feet below; and a variety of metamorphic and igneous rocks, including crystals of feldspar supposed to come from the crystalline complex of the mountains Apparently these pebbles prove that after the earlier coal measures were formed the mountains west of the Raton Mesa region were elevated and the upturned stratified rocks, having a measured

[1] Rept Pac Ry Surv, 5 230, 1856

[2] *Jour. Geol*, 17 149–151, 1909

thickness of more than 18,000 feet, were eroded before the basal conglomerate of the upper coal measures was laid down

The paleontologic evidence is almost wholly from the fossil plants, which apparently indicate a time break of considerable duration Large collections were made from both formations and F H Knowlton, who is studying them, states that they contain two distinct floras However, correlations are withheld pending the final study of these fossils

The data collected apparently prove that after the lower part of the coal bearing rocks in the Raton Mesa region, heretofore referred to the Laramie, had been consolidated the mountains to the west were uplifted and part of these rocks, together with all of such younger beds as may have been deposited, were eroded away before deposition of sediments was resumed in this region The general conclusion is reached that the so called Laramie of the Raton Mesa is divisible into two distinct formations separated in time by a period of considerable duration.

ROBERT ANDERSON,
Secretary

THE TORREY BOTANICAL CLUB

THE meeting of December 13, 1910, was called to order at the American Museum of Natural History at 8 30 P M, Tuesday, December 13, 1910, with President Rusby in the chair One hundred people were present

The scientific program consisted of an illustrated lecture by Dr Marshall A Howe on "A Visit to the Panama Canal Zone"

The visit described by the speaker occurred in December, 1909, and January, 1910, and was undertaken under the auspices of the New York Botanical Garden, with the special object of studying and comparing the marine floras of the Atlantic and Pacific oceans, here within less than fifty miles of each other

The marine algæ proving unexpectedly scarce, especially on the Pacific side of the isthmus, there was considerable opportunity for taking photographs of general botanical interest and the lantern slides shown illustrated chiefly some of the more striking features of the land flora of the Canal Zone, such as the numerous native palms, the vegetation of the extensive fresh water swamps between Colon and Gatun, the swampy forests bordering the Chagres River, and the flora of the rocky islands of Panama Bay A report covering some of these features of the lecture was published in the *Journal of the New York Botanical Garden* for February, 1910

The speaker justified a somewhat extended discussion of the Panama Canal and its history by the general interest in the subject both here and on the isthmus Among the photographs shown were several of the Atlantic and Pacific entrances to the canal, the Gatun locks, a flood on the Chagres River, the Culebra Cut, the Ancon Hospital and the Taboga Sanitarium. The success of modern sanitary methods in combating yellow fever and malaria was especially dwelt upon. The speaker alluded also to incidents of interest in the romantic early history of the isthmus and in the building of the Panama Railroad. Photographs of the ruins of Old Panama, located about five miles east of the present city, were also shown

SERENO STETSON,
Secretary pro tem

THE AMERICAN CHEMICAL SOCIETY
NEW YORK SECTION

THE fifth regular meeting of the session of 1910–11 was held at the Chemists' Club on February 10

The chairman spoke of the great loss to the society in the death of Professor Kinnicutt and called upon Dr Clifford Richardson to make a few remarks about his career Professor Morris Loeb paid a further tribute to Professor Kinnicutt and then, passing from a matter of deep regret to one of rejoicing, spoke of the festivities connected with the opening of the new chemists' building in New York, beginning March 17

The chairman read a letter of regret from Professor Boltwood, who was unable to be present to read a paper on "Radio-chemistry," announced on the program He then called upon Professor A T Lincoln, of Rensselaer Polytechnic Institute, who presented a résumé of recent work on the subject of solutions under the title "The Hydrate Theory."

The rest of the evening was devoted to a symposium on milk, which comprised the following subjects:

"Determination of Total Solids in Milk," Paul Poetschke, of the Lederle Laboratories

"Milk Costs," W E J. Kirk, medical adviser to the Borden's Condensed Milk Company

"Raw and Pasteurized Milk and Milk Serums," Edward Gudeman, of Chicago.

C M JOYCE,
Secretary

SCIENCE

FRIDAY, MARCH 10, 1911

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THE INFLUENCE OF ASTRONOMY ON MATHEMATICS

THERE are probably many reasons why the members of the eleven sections of the American Association, representing at least fifteen sciences, have united in a single society. One of these is undoubtedly that the mingling of men of varied chief interests, points of view and methods of work has at least a tendency to correct those intellectual provincialisms which are characteristic of isolation, and to show how wide and how rich is the field of scientific activity. While it is unquestionably advantageous on some occasions for narrower groups of men whose interests are more nearly common and whose scientific activities run more nearly in the same channel, to meet apart for the consideration of their own special problems, yet on the whole the benefits to be derived from occasional joint meetings are so great that it is earnestly hoped the American Association will prosper in the future even more than it has prospered in the past, and that the individual scientific societies will not cease to cooperate with it.

If it is agreed that there are real benefits to be derived from an association of many distinct scientific societies, it will equally be granted that some advantages may be obtained from a meeting where so many points of view, modes of thought, and methods of investigation are represented as among the members of Section A. These diverse, and in some cases conflicting, points of view have arisen from the narrow specialization of recent times, and from the fact that the bounds of our knowledge have extended more rapidly

than our individual capacities for encompassing them Historically, astronomy and mathematics have been most intimately related In antiquity the roll of the celebrated masters in one of these sciences would almost exactly coincide with that in the other, and in more modern times the names of Newton, Euler, Lagrange, Laplace, Gauss, Cauchy, Poincaré and many others, which are equally honored by both astronomers and mathematicians, show how much they still have in common It is for this reason that in accepting our secretary's invitation to present a paper before you I have chosen to lay emphasis on these close relations, and in doing so I apologize only because I am so poorly prepared adequately to treat so worthy a theme If you will permit the interjection of a purely personal remark, I should like to state that it is not solely because of the close relations of astronomy and mathematics that I have chosen my topic, but because a most fortunate experience has taught me that the lack of sympathy, if not of respect, for the efforts in one domain by workers in another is due almost wholly to a lack of acquaintance with them I refer to the fact that for fifteen years I have been intimately associated with one of the former presidents of the American Association, with the present president, and with the vice-president of Section A The first has taught me how the mind of the naturalist works, how vivid and constructive is his imagination, how fertile he is in inventing hypotheses, how exhaustively he gathers his data, and how impartially he weighs evidence where prejudices easily might have influence, the second has shown me how keen are the intuitions of the physicist, how his quantitative estimates almost rival in accuracy mathematical calculations, and how his marvelous instruments increase the delicacy of our senses a million fold at a single leap, making it unnecessary for us to wait inconceivable ages for their evolution to that degree of perfection, the third has revealed to me how beautiful are the logical structures which can be built on independent and consistent hypotheses, how keen are the pleasures in establishing all the harmonious relations involved in a mathematical theory, and how great is the satisfaction in the discovery of that which is common and fundamental to many apparently distinct theories Here I confess my profound and equal respect for all these phases of scientific activity, and my belief that they are all of fundamental importance If in my attempts to accomplish something I follow more nearly along the line of one than another, it is because I believe that on account of personal tastes and training I am less likely to fail there than in the others

There does not seem to be a disposition on the part of any one to limit the field of activity of the astronomer He is supposed not only to know how to measure the distances, to calculate the motions, and to determine the composition of the heavenly bodies, but also to understand fully those complex factors which produce the weather changes, to be familiar with certain mysterious forces which bring good or bad luck to an individual, to have reliable data respecting the location of heaven and its antithesis, and to be an expert on the questions of the freedom of the will, the existence of an infinite being, and the immortality of the soul But the matter is quite different in the case of the mathematician Often he is criticized for busying himself with pure fictions of the mind rather than with the so-called actualities of physical problems It is no more passive antagonism, for there are many places in these halls to-day where a storm can be raised

by starting a discussion of imaginary numbers, hyperspace, or the non-euclidean geometries. It is easy to find men who will mark out the regions within which mathematicians should exercise their powers It is an interesting psychological phenomenon that a specialist who has spent many years on a subject and has become a recognized authority in it seldom, if ever, will make any definite and general statement in regard to it, yet often he will not hesitate to make sweeping dogmatic assertions respecting things entirely outside his line, for example (to use a harmless illustration), respecting the merits of the tariff or the crime of seventy-three Even those who have been expert in mathematics have differed much among themselves respecting what should be its highest aims Fourier, in reporting on the work of Jacobi to the Academy of Sciences, said that natural philosophy should be the principal object of the meditations of mathematicians In the introduction to his theory of heat referring to analysis he wrote "there could not be a language more universal and more simple, more exempt from errors and obscurities, that is to say, more worthy of expressing the invariable relations of natural objects Considered from this point of view, it is coextensive with nature itself, it defines all the sensible relations, measures the times, the spaces, the forces, the temperatures, this difficult science is formed slowly, but it retains all the principles it has once acquired. It grows and becomes more certain without limit in the midst of so many errors of the human mind." Replying to the reproach of Fourier, Jacobi, in a letter to Legendre, said: "It is true that M Fourier had the opinion that the principal end of mathematics was the public utility and the explanation of natural phenomena, but such a philosopher as he is should have known that the unique end of science is the honor of the human mind, and that from this point of view a question of number is as important as a question of the system of the world" Gauss agreed, for he said that mathematics is the queen of the sciences, and that arithmetic is the queen of mathematics

Obviously it is just that the astronomer should allow the mathematician all the latitude in defining the limits of mathematics that he himself would desire if he were permitted to mark out the borders of the field of astronomy It would be considered unwarrantable interference and an evidence of hopeless ignorance if any group of men should attempt to make astronomers confine themselves to those phases of their subject which are immediately useful to a busy world If astronomy were limited simply to those parts which are necessary for time service on the land and the use of navigators on the sea, if it were necessary to abandon those mathematical theories of the motions of the planets and satellites which are in all respects the most perfect examples in natural science of harmony between theory and observation, if it were no longer permitted to use our powerful instruments in observing the peculiarities of the planets and the sun, if we were compelled to discontinue our investigation as to their origin and evolution, if we were under obligations to give up the spectroscope forever, and if we were forced to forego all further attempts to sound the almost boundless depths of the sidereal system and unravel its mysteries, if astronomy were put under these restraints, I say, then most of those incentives which in all the history of astronomical science have produced the rarest examples of devotion to ideals and the pursuit of knowledge would be removed Astronomers do not admit the right of a partially informed

world to prescribe the boundaries for their activities, nor do they in turn feel qualified or even inclined to impose any limitations upon the mathematicians. They could not even say what kinds of mathematics will be of use to themselves or to other branches of physical science. To take an example old enough to be understood in correct perspective, the interval between the discovery of the properties of the conic sections by Menæchmus and their first practical use by Kepler was 2,000 years, or more than nine times that which separates us from Newton. Astronomers will admit, then, that if the sole purpose of mathematics were to serve the other sciences, it would not be safe to circumscribe it by any boundaries. And most of them, I think, will go much further and join me in the sentiment that mathematics, altogether apart from its uses in other subjects, has a right to exist, that it is a part of the universe of ideas which to a thinking being is no less real and important than the physical universe, that its proportions and its symmetries which find perfect expression in its wonderful symbolism are, in satisfying the esthetic tastes, on a level with the fine arts, and that the process of drawing its conclusions calls for an exercise of the best and highest faculties we possess. If we were required to describe the proper field of mathematics we might say simply that it includes at least all that which all mathematicians together claim belongs to it.

Having admitted the breadth of mathematics, we have to consider what part of it has had at least its initial inspiration in astronomy. It might, perhaps, be argued with a good deal of justice that all of mathematics has originated directly or indirectly in the experience of the human race, that our capacity for those particular modes of thought which are essential to its development have evolved under the stimulus of the physical world. It is significant, at any rate, that there is such wonderful harmony between the results obtained by mathematical processes and our experiences. But it is not the purpose here to make any such claims, or to become involved in the difficulties of metaphysical discussions. No thesis has been laid down which it is necessary to defend, and no claim that astronomy has had an important influence on mathematics will be filed except where the evidence is perfectly clear and conclusive.

It was noted in the beginning that in ancient times the astronomers were almost invariably also mathematicians and reversely, and consequently that it is difficult to separate the two sciences of that time so as to determine exactly the influence which each had on the other. But there is one case in which the demands of astronomical problems certainly stimulated the development of a mathematical theory. Trigonometry was invented by Hipparchus, who was the most eminent Greek astronomer, both as a practical observer and as a mathematician. He determined the length of the year correctly to within six minutes of its true value, the obliquity of the ecliptic to within five minutes of arc, the annual precession of the equinoxes to within nine seconds of arc, the distance of the moon to within one per cent of its value, the mean motions of the sun, moon and known planets, the changes in the moon's orbit, he made a catalogue of the fixed stars, etc. There is every reason to believe that these astronomical problems were those in which he was chiefly interested, and they made it necessary for him to develop trigonometry, and especially spherical trigonometry. His work was completed by Gauss nearly 2,000 years

latter in connection with the solution of the same problems

We shall not, however, get any comprehensive view of the relations of astronomy and mathematics by citing, without some classification, isolated examples where the latter is indebted to the former Such a procedure will give us no idea of the reasons for any of the great movements in mathematical thought Moreover, the mathematical theories are so interwoven that it is difficult to pick out individual branches and to discuss their origins without being at least very incomplete Therefore we shall content ourselves with broad classifications of mathematics, and to statements, with illustrations, of those parts where the practical problems of astronomy have had important influences

Mathematics may first be divided into the metrical and the non-metrical branches The former are vastly more important than the latter, or, since it is perhaps wise to avoid passing judgment as to what is important, the metrical branches have at least an enormously greater literature than the non-metrical Recognizing the fact that there is much of a non-metrical character in those subjects which are regarded as being on the whole metrical in nature, and not wishing to insist on the possibility of making an absolute division on this principle, an examination of the Royal Society Index covering publications in mathematics from 1800 to 1900 shows that probably not one part in forty has been devoted to non-metrical mathematics While there are certain non-metrical aspects of some astronomical problems, it would not be fair to claim that astronomy has had any essential part in inspiring these branches of mathematics.

Now considering only the metrical branches of mathematics, we may divide them into the mathematics of the continuous and the mathematics of the discrete Here the problem of actually effecting the division is even more difficult than in the preceding case, for there is more intermingling and there seem to be more debatable points In spite of these difficulties the mode of division is attached to certain fundamental characteristics either of the subject matter or of the processes employed The ordinary theory of numbers is an example of the mathematics of the discrete The theory of ordinary equations, for example, linear equations, may be considered as an example of the mathematics of the discrete or the continuous, according as the coefficients are regarded as discrete numbers or continuous functions of certain parameters In such cases where the ideas of continuity are not essential to the formulation and treatment of the problems, they will be considered as belonging to the mathematics of the discrete All those branches of mathematics in which continuity is an essential feature, as, for example, those involving derivatives, constitute the mathematics of the continuous

On the whole, the problems of astronomy have not given rise to the mathematics of the discrete While the physical universe seems to be made out of discrete things—atoms, corpuscles, units of electricity—it changes continuously from one state to another Since a large part of the problems of the natural sciences relate to changes of position or state, such as the motion of a world or the evolution of an animal, this continuity is forced into the foreground in the applications of mathematics to physical questions Consequently, in seeking for places where astronomy has made real contributions to mathematical theory we may restrict our search to the mathematics of the continuous If there are no other subjects which have made similar contributions, we have at once the

answer to the question of the extent of its influences. Since astronomy is more thousands of years old than most of the other natural sciences are centuries, it has naturally called forth most of those mathematical processes which have been needed in the others. About the only other natural science which has given rise to important mathematical theories is physics, which has forced attention to certain classes of partial differential equations and to the statistical methods employed in the kinetic theory of gases. Another important advantage astronomy has enjoyed is the delicate character of many of its observations and the high degree of precision of many of its theories. These have naturally directed attention to the questions of logical rigor. It is probably known to most of the members of this section that the numerically most perfect theory in all the range of physical science in all time is the lunar theory of our retiring vice-president. But the mathematics of the continuous has not been inspired by astronomy alone, or even by all the physical sciences together. In geometry the questions of tangents and areas have involved the same principles and have given rise to some of the same methods. Consequently we can conclude only that the problems of astronomy have given rise to some of the theories of the mathematics of the continuous.

It will perhaps be worth while to descend for a few minutes from the general to the particular, and to consider more concretely what contributions astronomy has actually made to mathematics. It is agreed by all that the invention of the calculus was one of the most important steps ever made in mathematics. It was founded first by Newton and a little later independently by Leibnitz. The work of either was sufficient to open the way to all that which has followed the invention of this important branch of mathematics. Newton's ideas were largely inspired by the consideration of physical phenomena, as is shown by the terminology and notation he used as well as by the problems to which he applied his methods. He spoke of *fluents* and *fluxions* and used the time as the independent variable, though he knew this was not essential. It simply indicates the stimulus of his ideas. On the other hand, Leibnitz used the terminology of geometry and seemed to have arrived at his ideas of derivatives through the consideration of tangents to curves. These differences constitute an internal evidence of the independence of the work of Newton and of Leibnitz.

The history of the application of the calculus in the century following its discovery constitutes one of the most glorious records of the achievements of the human mind. Mathematicians had a new method of enormous power and the greatest generality, while the laws of motion and the law of gravitation were the keys that unlocked a new universe to them. The work of Clairaut, d'Alembert, Euler, Lagrange and Laplace was one succession of triumphs. With the enthusiasm of explorers they traversed the worlds Newton and Leibnitz had opened, and with Laplace it was supposed the discoveries in them were about exhausted. The point to be emphasized here is that whatever may have been the origin of the calculus, its evolution into the larger domain of analysis in the century following its invention was due almost entirely to the stimulus of physical, and in particular astronomical, problems. There does not seem room for doubt that the very important place which analysis now occupies in mathematics is to a large extent due to its applications to astronomy.

Astronomy not only turned the attention of mathematicians to analysis, but it often determined the precise form their theories

should take. Consider, for example, analytic differential equations. There are five distinct methods of developing their solutions—as power series in the independent variable, as power series in parameters, as limits of equations of finite differences, by successive approximations, and by successive applications of the variation of constants—all of which were devised under the pressure of practical astronomical problems and were applied successfully many years before the conditions of their legitimacy were fully established by mathematical methods. A more recent example is Hill's treatment of the linear differential equation having simply periodic coefficients, the properties of whose solutions were inferred by him from the properties of the motion of the moon. The problems connected with an infinite number of simultaneous homogeneous linear equations also arose in Hill's lunar theory. Poincaré's researches in the problem of three bodies led him to the discovery of many new properties of the solutions of differential equations. The question of the legitimacy of the series used in celestial mechanics, particularly when applied for long intervals, has forced a consideration of the problem of determining what classes of divergent series may be used and what conclusions may be drawn from them, and the same question has stimulated investigations of other modes of representing solutions, particularly as sums of polynomials in the independent variable, having wider domains of validity. In this direction Painlevé has achieved the most important results, and has shown how to construct functions which represent the solution of the general problem of n bodies so long as there are no collisions. If the forces were repulsive instead of attractive the developments would be valid indefinitely. But as Laplace said "nature does not care for analytical difficulties", in fact, it fills the way of the mathematician with them. As a partial recompense for the difficulties it raises it often suggests methods for overcoming them, and these methods being made general in the symbolism of mathematics constitute new processes often applicable in many other directions.

One of the recent movements in mathematics is in the application of the postulational method. It consists in postulating the existence of certain elements which are wholly without properties except as they are imposed by the postulates and the explicitly stated axioms. The postulates and their implications constitute the theory. It is not to be supposed that the postulates are laid down at random, or even on any simple principle of their individual and separate characteristics. The sole guide is that taken together they shall yield as consequences certain relations which are in advance in the consciousness of the investigator, the additional implications are the contributions which the developed theory makes. I do not know why there has sprung up the recent interest in this method, but it is fundamentally the method used in natural science. The experiences are the certainties given in advance which must be implications of the theories. The atoms, corpuscles, units of electricity, etc., are the postulated elements. The theories are the postulated relations among the elements. If we let $a_1, \ldots, a_n$ represent the experiences, $x_1, \ldots, x_m$ the postulated elements, then we shall have

$$f_i(x_j) = a_i,$$

where the f_i are the theories. If one of these relations fails to hold it is necessary to modify the x_j, or the f_i, or both, and it is easy to cite examples from the history of science illustrating all these possibilities. The recognition of the fundamental iden-

tity of the process of constructing theories in the realms of natural science and of developing mathematics by the postulational method will undoubtedly be of great value to the former in showing what is really essential, and to the latter in inspiring almost endless points of view.

It is not necessary to cite more examples to show that mathematics owes much to astronomy, especially in the field of analysis. If it were proper to strike a balance it could probably be shown that the debt has been more than repaid, but in these unselfish sciences the privileges of foreign service are cherished as much as the treasures of domestic achievements, and therefore we content ourselves with the recognition of the interrelations.

In closing I may point out the truism that these interrelations are not limited to astronomy and mathematics. It is to the glory of astronomy that in it were initiated the two most fundamental intellectual movements in the history of mankind, viz., the establishment of the possibility of science and of the doctrine of evolution. Our intellectual ancestors in the valleys of the Euphrates and the Nile and on the hills of Greece looked up into the sky at night and saw order there and not chaos. By painstaking observations and calculations they discovered the relatively simple laws of the motions of the heavenly bodies, whose invariable and exact fufilment led to the belief that the whole universe in all its parts is orderly and that science is possible. In the modern world this conclusion is so commonplace that its immense value is apt to be overlooked, but a study of the superstitions and the hopeless stagnation of those portions of mankind which have not yet made the discovery gives us some measure of its worth. The modern supplement to the conception that the universe is not a chaos is that not only is it an orderly universe at any instant, but that it changes from one state to another in a continuous and orderly fashion. This doctrine that science is extensive in time, as well as in space, is the fundamental element in the theory of evolution and the completion of the conception of science itself. The ideas of evolution in a scientific form were first applied to the relatively simple celestial phenomena. More than a century before the appearance of Darwin's "Origin of Species," and the philosophical writings of Spencer, another Englishman, Thomas Wright, published a book on the origin of worlds. Laplace's nebular hypothesis gave the geologists a basis for their work, which in turn paved the way for that of Darwin. For half a century now the doctrine of evolution has been a fundamental factor in the elaboration of all scientific theories, and its influence has spread to every field of intellectual effort. It has been the good fortune of mankind that his skies have sometimes been free of clouds and that he has been able to observe those relatively simple yet majestic and impersonal celestial phenomena which have not only led to so important results as the founding of science and the doctrine of evolution, but have strongly colored his poetry, philosophy and religion, and have stimulated him to the elaboration of some of his most profound mathematical theories.

F. R. Moulton

University of Chicago

STATISTICS OF GERMAN UNIVERSITIES

The twenty-one German universities show an enrollment for the winter semester of 1910–11 of 54,822 students, as against 53,407 students last winter. During the past five years there has been an increase in registration of no less than 12,482 students. Curiously enough, the winter enrollment exhibits a decrease, although only of a few students, against the previous summer semester, in which

54,845 students were enrolled. The number of women students has grown from 211 five years ago to 2,418 this winter. There has been an increase in the number of students of medicine, philology and history, pure science, and Protestant theology, and a small gain in the number of students of Catholic theology, while there has been a decrease in the number of law students and in the students of dentistry and pharmacy. By faculties and groups the students were distributed as follows: Protestant theology, 2,535 (as against 2,820 in the winter semester of 1909–10); Catholic theology, 1,760 (1,698); law, 10,890 (11,317), medicine, 11,240 (10,135), dentistry, 1,146 (1,395), philosophy, philology and history, 15,525 (14,593); pure science, 7,914 (7,349), pharmacy, 954 (1,279), agriculture, 2,546 (2,085), forestry, 171 (129), veterinary medicine, 141 (107).

So far as the individual universities are concerned, those of Prussia show a larger increase than those of Bavaria and Baden, the ten Prussian universities having enrolled 28,675 students as against 27,244 last year, whereas the three Bavarian universities show an increase from 9,042 last winter to 9,842 this winter, and those of Baden from 4,101 students to 4,254 students; the remaining six German universities have increased their clientele from 11,980 to 12,552 students. The three largest universities (Berlin, München and Leipzig) alone enrolled no less than 39 per cent. of the total German student body, Berlin remaining at the top with an enrollment of 9,686 students, as against 9,242 last winter. This is followed by the University of München with 6,905 students (6,587 last year). The remaining universities range in the following order: Leipzig, 4,900 (4,761); Bonn, 3,846 (3,652); Halle 2,661 (2,393); Breslau, 2,454 (2,405); Freiburg, 2,246 (2,167); Göttingen, 2,283 (2,230), Strassburg, 2,067 (1,995); Münster, 2,047 (1,906); Heidelberg, 2,006 (1,934); Marburg, 1,981 (1,878); Tübingen, 1,883 (1,760); Jena, 1,637 (1,496); Kiel, 1,439 (1,290); Würzburg, 1,425 (1,424); Königsberg, 1,380 (1,367); Giessen, 1,249 (1,261); Erlangen, 1,011 (1,121), Greifswald, 948 (881), and Rostock, 816 (707).

The figures show that all the universities with the exception of Erlangen, Wurzburg and Giessen have increased their attendance, the smallest gains having been made by Göttingen, Konigsberg and Breslau, the largest (in percentage) by Halle, Kiel, Jena, Tübingen and Rostock. Since last winter Breslau has been passed by Halle, Gottingen by Freiburg, Heidelberg by Munster, Wurzburg and Konigsberg by Kiel.

In addition to the 54,822 matriculated students, 3,528 men and 1,772 women are enrolled this winter as auditors, giving a total of 60,122 individuals receiving instruction at the German universities, the largest number in the history of German higher education.

RUDOLF TOMBO, JR.

COLUMBIA UNIVERSITY

MEMORIAL TO CHARLES OTIS WHITMAN

VOLUME 22 of the *Journal of Morphology* will be a Charles Otis Whitman Memorial Volume. This volume was originally intended as a testimonial by former students and colleagues to the founder of the *Journal of Morphology*, Professor Charles Otis Whitman. In view of his untimely death it becomes a memorial volume. In addition to a large number of scientific papers by Professor Whitman's students and associates, illustrated with numerous plates and text figures, it will contain a biographical sketch with portraits of Professor Whitman. The edition of this volume will be sufficient to supply special orders in addition to the regular subscriptions to the *Journal of Morphology*. The contents will be as follows:

"The Sex Cells of *Amia* and *Lepidosteus*," B. M. Allen.

"Male Organs for Sperm-transfer in the Crayfish, *Cambarus affinis*, their Structure and Use," E. A. Andrews.

"Vertebrate Cephalogenesis." 3. "*Amphioxus* and *Bdellostoma*," Howard Ayers.

"On the Bilaterality of the Pigeon's Egg, a Study in Egg Organization," G. W. Bartelmez.

"The Regulatory Process in Organisms," C. M. Child.

"Cell size and Nuclear Size," E. G. Conklin.

"Oviposition Induced by the Male in Pigeons," Wallace Craig.

"The Life History of the *Scolex polymorphus* of the Woods Hole Region," W. C. Curtis.

"The Transplantation of Ovaries in Chickens," C. B. Davenport.

"On the Regular Seasonal Changes in the Relative Weight of the Central Nervous System of the Leopard Frog," Henry H. Donaldson.

"Spermatogenesis in the Arenicolidæ," E. R. Downing.

"Reproductive Activities of the Squid," Gilman A. Drew.

"Modifications in the Testes of Hybrids from the Guinea and the Common Fowl," M. F. Guyer.

"Some Problems of Cœlenterate Ontogeny," C. W. Hargitt.

"Minimal Size Reduction in Planarians through Successive Regenerations," S. J. Holmes.

"Studies in Fertilization in *Nereis*." 1. "The Cortical Changes in the Egg." 2. "Partial Fertilization," F. R. Lillie.

"The Physiology of Cell division." 4. "The Action of Pure and Calcium containing Salt-solutions, followed by Hypertonic Sea water, on the Unfertilized Eggs of *Arbacia*, with a Theory of the Physics of Certain Features of Mitosis from the Standpoint of the Membrane Theory of Bioelectric Processes," Ralph S. Lillie.

"Anatomical Illustrations before Vesalius," W. A. Locy.

"The Growth and Retrogression of *Corpus luteum* in the Guinea pig," Leo Loeb.

"The Chemistry of Fertilization," A. P. Mathews.

"The Influence of Inbreeding and Selection on the Fertility and Sex Ratio in *Drosophila*," W. J. Moenkhaus.

"The Spermatogenesis of the *Hempteron Euschistus*," T. H. Montgomery, Jr.

"Further Studies of Ovogenesis and Spermatogenesis in Phylloxerans and Aphids," T. H. Morgan.

Studies of Variation and Heredity in the Armadillo," H. H. Newman and J. T. Patterson.

"Foot Movements of Molluscs," G. H. Parker.

"The Evolution of the Pearl Organs of American Minnows and Suckers. A Study in the Factors of Descent," Jacob Reighard.

"White and Yellow Yolk in Vertebrate Ova," Oscar Riddle.

"The Structure and Periodicity of the Developing Salpa Chain," W. E. Ritter (With Miss Myrtle Johnson).

"Physiological Animal Geography," V. E. Shelford.

"The Olfactory Organs and the Sense of Smell in Birds," R. M. Strong.

"The Behavior of the Chromosomes in Cross-fertilized Echinoid Eggs," D. H. Tennent.

"Experimental Modification of the Germplasm," W. L. Tower.

"The Ant colony as an Organism," W. M. Wheeler.

"Studies in Chromosomes." 7. "A Review of the Chromosomes of *Nezara* with some more General Considerations,' E. B. Wilson.

"*Paramæcium caudatum* and *Paramæcium aurelia*," L. L. Woodruff.

"Experiments in the Control of Asymmetry in the Development of the Serpulid, *Hydroides dianthus*," Charles Zeleny.

Titles of papers of the following not received: H. McE. Knower, Jacques Loeb, F. P. Mall.

SCIENTIFIC NOTES AND NEWS

THE congress has passed a bill to retire Commander Robert E. Peary, with the rank and pay of a rear-admiral and to extend to him the thanks of congress.

THE vacancy in the board of consulting scientific experts to the secretary of agriculture, caused by the death of Dr. C. A. Herter, has been filled by the appointment of Dr. Theobald Smith, of Harvard University. The appointment was made by the secretary of agriculture, with the full approval of President Taft.

THE Helmholtz medal of the Berlin Academy of Sciences was awarded to Professor van't Hoff shortly before his death.

SIR WILLIAM H. WHITE has been awarded the John Fritz medal for 1911, for "notable achievements in naval architecture," by the board representing the national societies of civil, mining, mechanical and electrical engineering. The first award was made in 1905 to Lord Kelvin, and subsequently to Alexander Graham Bell, Thomas A. Edison, George Westinghouse, Charles Porter and Alfred Noble.

THE gold medal of the British Institution

of Mining and Metallurgy has been awarded to Sir Julius Wernher, in recognition of his services to technological education and in the promotion of the interests of the mining and metallurgical professions.

Dr. L A Bauer was made an honorary member of the Royal Cornwall Polytechnic Society of England at its recent annual general meeting

The Academy of Natural Sciences of Philadelphia has elected Dr Walter Rothschild, of Tring, England, a correspondent

Professor Bier, director of the surgical clinic at Berlin, has been elected a foreign member of the Berlin Academy of Sciences

Mr Norman Taylor, editor of *Torreya*, and assistant curator at the New York Botanical Garden, has been appointed curator of plants in the newly established Brooklyn botanic garden

Dr Clarence J Marshall, professor of veterinary medicine at the University of Pennsylvania, has been appointed veterinarian of the state of Pennsylvania

David Albert Molitor, professor of topographic and geodetic engineering in the College of Civil Engineering of Cornell University, has resigned from the faculty and returned to active practise

Dr Henry C. Taylor, professor of agricultural economics at the University of Wisconsin, has been elected associate editor of *The American Economic Review*, published by the American Economic Association Dr Taylor will have charge of the subject of agricultural economics

Dr Alice Hamilton, of the Memorial Institute for Infectious Diseases, of Chicago, who investigated the lead industries of Chicago and Illinois with reference to lead poisoning for the Illinois Commission on Occupational Diseases, is undertaking similar work for the federal government

The Frederick Sheldon traveling fellowship of Harvard University has been awarded to Latham Clarke, Ph D, instructor in industrial chemistry

Professor Giuseppe Mercalli has been appointed director of the observatory on Mt Vesuvius, to succeed Professor Matteucci

Professor E B Wilson lectured on "Heredity and the Cell" before the Society of Sigma Xi of Columbia University on February 23

Dr L H Bailey, director of the New York State College of Agriculture at Cornell University, delivered a lecture under the auspices of the Pennsylvania Chapter of the Society of the Sigma Xi on February 27, on the subject of "The Country Life Situation"

Two Sigma Xi lectures, one on "Attention" and one on "Types of Mind," were given at the University of Minnesota, on February 9 and 10, by Professor E B Titchener, Sage research professor at Cornell University.

The Columbia chapter of the Phi Lambda Upsilon, the honorary chemical fraternity, was addressed by Dr H W Wiley, of Washington, D C, on February 18 In his address on the "Relation of Chemistry to the Public Welfare" Dr Wiley showed the moral influence which a chemist exerts on the community and the position which a chemist will assume in the fight against disease An informal reception to Dr Wiley was tendered by the society after the address to welcome him as a member

The annual meeting of the Illinois State Academy of Science was held at the University of Chicago on February 17 and 18 Professor J M Coulter, head of the department of botany of the university, delivered the presidential address on "The Problems of Plant Breeding"

On January 21 the Oregon Academy of Sciences met in regular monthly meeting, the address being by W. N. Ferrins, president of Pacific University and one of the Rhodes scholarship committee for the northwest His subject was "The Rhodes Scholarships and Oxford University" On February 18 Wm T Foster, president of the new Reed College, of Portland, spoke on "The American College," giving a brief review of the history of European colleges At the March meeting Pro-

fessor Albert Sweetser, biologist of the University of Oregon, will deliver an address.

THE Society of College Teachers of Education held its convention during the sessions of the Department of Superintendence of the National Education Association on February 23 and 24 in Mobile, Ala. The president of the society was Charles H. Judd, professor of education in the University of Chicago.

PROFESSOR ARTHUR KEITH, conservator of the museum of the Royal College of Surgeons of England, gave in February a course of six Hunterian lectures on the fossil remains of man, and their bearing on the origin of modern British types.

AFTER the scientific program, at the session of the Philadelphia College of Physicians, on February 1, Dr. Robert Abbe, New York City, presented to the college the gold watch of Benjamin Rush, and Dr. William W. Keen, on behalf of the donors, presented to the college a portrait of Dr. William Goodell, the gynecologist.

BY the instructions of the London County Council, as we learn from *Nature*, a blue tablet of encaustic ware has been affixed to No. 32 Soho Square, W., at one time the residence of Sir Joseph Banks, who was elected president of the Royal Society in 1778 and held that office for forty-one years.

SIR JOHN MURRAY will give his memorial address on "The Life and Scientific Works of Alexander Agassiz," at Sanders Theater, Harvard University, on Wednesday evening, March 22, at eight o'clock. On account of Sir John Murray's illness this lecture was postponed from February 14.

DR. WALTER REMSEN BRINCKERHOFF, assistant professor of pathology in the Harvard Medical School, the author of important researches on small-pox and leprosy, died in Boston, on the second of March, in the thirty-seventh year of his age.

THE death is announced from Berlin of Professor J. H. van't Hoff, eminent for his contributions to physical chemistry.

DR. ALOYSIUS OLIVER JOSEPH KELLY, assistant professor of medicine in the University of Pennsylvania and professor of pathology in the Woman's Medical College of Pennsylvania, died on February 23, at the age of forty-one years.

THE second Central American Expedition of the School of American Archeology reached Guatemala on January 14 and steps were immediately taken to continue the work inaugurated the preceding year. After a preliminary survey of the southern Maya field year (January, 1910), it was decided that the School of American Archeology would undertake the excavation and repair of the ruins of Quirigua in the Department of Izabal, some fifty miles from the Atlantic coast. During the first expedition the ruins were surveyed, and a park laid out surrounding them. The Great Plaza was cleared of underbrush and the monuments were cleaned, photographed and measured. A first hand study of the art and inscriptions was undertaken and in both cases the inadequacy of photographs and casts for definitive conclusions was demonstrated. The second expedition will continue the work from this point. The luxuriant tropical vegetation in which the ruins lie buried will be felled and means taken to prevent the annual reappearance of this destructive agent. The laying bare of this site, the clearing of the various pyramids, courts and temples will doubtless be the main work of the present season, though excavations will also be made and the study of the art and inscriptions continued.

THE Lake Laboratory of the Ohio State University has announced its courses for the summer session of 1911, and covers practically the same ground as in previous seasons. The staff includes representatives from a number of Ohio Colleges, including Professors Brookner, of Buchtel, Coghill, of Denison, Fullmer, of Baldwin; Osborn and Landacre, of Ohio State University, and Jennings, of the Carnegie Museum in Pittsburgh, with one position, in ornithology, yet to be filled. The subjects covered are general zoology, aquatic biology, invertebrate zoology, entomology,

ornithology, experimental zoology, embryology, general botany and ecology, each in charge of a specialist in the subject The opportunities of work in these lines are very favorable, the laboratory being located on Cedar Point with access to Lake Erie, on the one side, and Sandusky Bay, with its marshes and open water, on the other side It is also quite near the islands and to all points of zoological interest The session opens on June 19, and further information concerning the work or copies of the announcement may be obtained by application to the director, Professor Herbert Osborn, Ohio State University, Columbus, Ohio.

A BIOLOGICAL club has been organized at the Oregon Agricultural College by the faculty and graduate students to make studies of the biology of the state Professor H S Jackson, of the department of botany, was made chairman for the coming year with George F. Sykes, of the department of zoology, as secretary. The club voted to make one of its first problems a thorough biological survey of Mary's Peak, a work which will occupy at least two years Through the meetings, field trips and collection of material, it is hoped to add materially to the present knowledge of the biology of the state, while at the same time interest will be stimulated in the study of biology

THE sixty-third meeting of the American Society of Mechanical Engineers will be held in Pittsburgh, Pa, from May 30 to June 2, inclusive. The society has not met in this city since 1884. The headquarters of the society are in New York City, and Col E D. Meier, of St Louis, is president this year The society has in the Pittsburgh district alone a membership of about one hundred and sixty. Last year the society held a joint meeting in England with the British Society, the Institution of Mechanical Engineers An executive committee consisting of E M. Herr, chairman, George Mesta, J. M Tate, Jr, Chester B. Albree, D. F. Crawford, Morris Knowles and Elmer K Hiles, secretary, will have charge of the Pittsburgh meetings. There will be professional sessions when papers will be read and discussed There will also be inspection trips through the leading local industrial establishments

THE progress of the graduate electrical engineering work at the Massachusetts Institute of Technology is indicated by the number of students who are candidates for higher degrees, which number is now greater than last year. The number of students in the undergraduate course in electrical engineering is also steadily increasing so that additional teaching staff is being added to the corps of laboratory instruction Various lines of research are being carried on in the department mostly under the direction of Professor Pender and Professor Wickenden Some of these relate to the effects of heat treatment on the magnetic qualities of silicon iron, certain transient phenomena that may occur in long electric circuits, the effect of high frequencies on the permeability of iron, the effective resistance and reactance of steel rails when conveying alternating currents, the selective action of spark gap lightning arresters with respect to frequency, the reflection of light from walls and ceilings, the disruptive strength of rubber insulated coatings, on wires, etc. Certain of these are continuations of work started last year, and researches in each will be carried on as may be convenient and needful to get knowledge of the phenomena under investigation The results of the thesis research of Dr Harold Osborne on whom the degree of doctor of engineering (the first conferred by the institute) was conferred last June, were embodied in a paper presented before the American Institute of Electrical Engineers at its October meeting The subject of illumination and photometry has been added to the subjects taught in the electrical engineering department This is treated from the standpoint of what is generally called illuminating engineering and is made an optional study

IT is reported that the Italian government will establish a Vulcanological Institute, for which the chief governments will be invited to contribute £60,000. Mr. Immanuel Friedlaender, who resides in Naples and is the author of a work on the volcanoes of Japan, has promised, it is said, £4,000 towards this fund

THE second Shaler Memorial Research, supported by the Shaler Memorial Fund of Harvard University, will consist of a study of shoreline changes along the Atlantic coast by Professor D. W. Johnson and two or three assistants. Special attention will be given to changes in the form of beaches within recent geological time, and to supposed evidences of recent coastal subsidence. Since the problem of coastal subsidence is affected by the relative heights of high tides on the outer and inner sides of barrier beaches, lines of levels will be run between the ocean and lagoons, upon which tidal observations will be based. The most important localities from the Bay of Fundy to southern Florida will be examined during the spring and early summer. During the latter part of the summer Professor Johnson will visit localities on the coasts of England, Holland and Sweden, for the purpose of making comparisons with similar localities on the Atlantic coast of North America.

UNIVERSITY AND EDUCATIONAL NEWS

M. AUGUSTE LOUTREFIL has bequeathed $700,000 to the Paris Academy of Sciences, $500,000 to the University of Paris and $20,000 to the Pasteur Institute.

THE University of Michigan has received a gift of $10,000 from William J. Cook, now of New York, and formerly of Hillsdale, Mich., to be used toward the erection of a residential hall for women.

BY the will of Miss Susan G. Lansing, of Albany, N. Y., Rutgers College receives the sum of $5,000, together with one third of the residuary estate, which, it is estimated, will bring about $10,000 additional.

THE residue under Sir Francis Galton's will is bequeathed to the University of London for the encouragement of the study of eugenics.

THE technique of printing and publishing is a new course of study at the University of Wisconsin in connection with the course in journalism. It is designed for students of agriculture, engineering and commerce, who are preparing to enter technical and trade journalism. A class in technical and trade journalism has been organized to give further training in this field.

THE University of Illinois special train to rural schools started out for a two weeks' trip over the Illinois Traction system on February 27. The special consists of two cars fitted up with illustrative material for the use of the speakers who accompany the train. About one thousand children are visiting this special every day. The county superintendent of schools of each county that the special visits accompanies the party and acts as guide and director.

PROFESSOR V. H. BLACKMAN, of Leeds, has been appointed to the professorship of plant physiology and pathology at the Imperial College of Science and Technology, London.

DISCUSSION AND CORRESPONDENCE

THE USE OF NUMERALS FOR SPECIFIC NAMES IN SYSTEMATIC ZOOLOGY

IN a recent number of SCIENCE, Dr. Needham has suggested the use of a numerical system of naming species, in addition to the present binomial system devised by Linnæus.

To this suggestion there are several objections, which to the practical worker in taxonomy seem wholly insuperable. In the first place, the name of an animal is not the main element concerned. The specific name covers our conception of the species, a conception likely to be greatly modified by thorough study. The generic name indicates our conception of where it belongs. This conception, of necessity, changes with the progress of knowledge. The changes in name mark such progress. To the taxonomist, certain changes of name are as real and as important as any other forward step in science. It is of course unfortunate that some species have had many different names. So have many genera also. This is due primarily to the inherent difficulties of the subject, as few branches of knowledge are more intricate than the study of the genetic derivation of forms, and their exact geographical distribution. These two branches of science, taxonomy and zoogeography, must

depend for their existence on exactness in nomenclature. Besides this, it often happens that a publication in one nation may be unknown in another, that different writers reach the same results almost simultaneously and independently, and still worse, that some writers are careless or ignorant of the literature, or have felt free to improve on the work of their predecessors by changing, not their conceptions, but the names they have given.

This condition in which anybody called any animal or plant what he pleased went on for more than eighty years after the publication of the "Systema Naturæ." It was evident that all exactness in nomenclature was being lost and that the only way out was through the law of priority and through considering systematic zoology as a democracy in which there was no respecting of persons. Since the first attempt at the recognition of the law of priority in nomenclature, we have come by degrees to relative stability. So far as the first name given to species or a genus was concerned, this name, unless already in use, is right. All the others are wrong. To those who regard rules, the number of names doubtful from the standpoint of nomenclature is now but a very small proportion of the total number. Those zoologically doubtful are naturally far more numerous.

The many zoological problems involved must be settled by observation of the facts in nature, not by rule. There is scarcely a species of which we finally and completely know the actual boundaries. The value and limitation of generic groups changes with every increase of knowledge. Forms once placed side by side are shown to belong far apart. Those far apart are often brought together. In this regard, there can be no stability until the facts are all in. A nomenclature absolutely stable would represent intellectual stagnation.

But to the systematic worker in any field, the actual changes bring no great inconvenience. Names are nothing without ideas. His difficulties do not lie in the remembering of names, but in getting the facts to which names are the handles. The postman is not worried over the fact that each town has a name, and that it belongs to some county, and that there are many counties in many states. If he has troubles, it is not because there are so many names, but because there are so many towns and so many people to be named. So with the taxonomist in any field.

To the worker in other lines in biology, who asks of taxonomy nothing save the name of the animal he is working on, all suspense is aggravating. He wants the scientific name once for all, and he doesn't want it changed. We are sorry that we can not accommodate him, but a name as such is not the main question with the taxonomist. We may let the anatomist keep for his own purposes such names as *Amphioxus*, although the taxonomist can not use it, because the group had a name before *Amphioxus* was invented. The anatomist may in time get used to *Branchiostoma* just as he has become reconciled to *Necturus*, in place of the much later *Menobranchus* once sacred to his purposes.

The fact that a name seems to be in common use just now is no argument for its permanence. The next generation realizing more and more the value of law and order, will discard the name that should not legitimately be used. It is just as necessary in taxonomy and in zoogeography to have a clear-cut nomenclature—above all whim or personal preference—as it is in anatomy to have clean knives, or in histology to have trustworthy staining fluids.

As to the substitution of numbers for specific names or their use in place of such names, we have first the minor objection, of inaccuracy. There will be a dozen errors in a column of figures to one in a column of names, because with the numerals the memory has nothing to hold to. If you live at No. 163 West 135th St. half your letters will be misdirected. This can be easily tested. The dead-letter office is sending back to me letters I directed to 916 East 19th St., and to 919 East 14th St., which should have gone to 914 East 19th, and I have now to write those figures twice to be sure that they are right. No. 256 Knickerbocker Avenue does not have this trouble. Besides, misprints in names correct

themselves Slips in numbers can not do so.

But waiving all this, the plan seems utopian Let us look at its application to the group of fishes There are about 12,500 known species of fishes, arranged in about 2,500 genera Over 4,000 genera have been named and upwards of 30,000 to 40,000 species Of these names, perhaps 10,000 are known to be synonyms, the result of some one's misfortune or carelessness The majority of the supposed species have not been tested The seas are large, there are many rivers, and but few men who study these animals thoroughly In our system of numbers shall we count real species or merely count names? Manifestly it is only the names which we can use, for we do not know half the species well enough to assign them a final place Again, shall we number all species of fishes from 1 to 40,000—or shall we number them by groups or by genera? In any case, a single man or bureau must do all the numbering for all the world, else we should have a crossing of numbers. I might use 38,927 for my cat-fish, while my Russian friend might claim it for a sturgeon If we number by genera, my *Ameiurus* 36 may not be the same as my friend's *Ameiurus* 36 issued at about the same time Or one or the other might make an error, or misprint, duplicating what is already numbered

We must then have in each group a central numbering bureau, a bureau which shall have the means to go back and number all the forgotten species already in literature We would have to do this before the work could begin Our American channel cat, *Ictalurus punctatus*, has received some 27 specific names after it was called *Silurus punctatus*. To do it justice, we must refer to it as *Ictalurus*, 5, 27, 36, 38, etc., thus including the whole list of synonyms, any one of which some one some time may show to be valid. But the channel cat was not originally called *Ictalurus*. This raises the question as to whether you would list it as *Silurus*, which it is not, or as *Ictalurus*, which it is, or as *Ameiurus*, *Elliops*, *Synechoglanis*, *Pimelodus* or other generic names under which synonyms its species have been recorded.

Manifestly they must be listed under the original generic name, for no one yet knows the final boundaries of the modern genus. The modern genus consists of a group of species clustering round its original type The boundaries between *Ictalurus*, the channel cat, and *Ameiurus*, the ordinary cat fish, are still uncertain There are species intermediate, with the head of *Ameiurus* and the tail of *Ictalurus*, and it may be that the two must coalesce So the same channel cat may be *Silurus* 25, *Ameiurus* 29, *Pimelodus* 75, *Synechoglanis* 1. Under the law of priority, it can have but one right name This is *punctatus*, the oldest specific name attached to its right genus, which, as we now understand it, is *Ictalurus*

But let us start the numbering and see where we come out Shall we begin with the lowest fish or with the fish first made known? Our system of nomenclature begins on January 1, 1758 The first fish named is the common lamprey, *Petromyzon marinus* *Petromyzon* offers no difficulty, except that according to Linnæus, *Petromyzon* is not a fish, but an amphibian His *Amphibia nantes*, or swimming amphibians, in his mind are not real fishes

Passing on to the first species actually called a fish by Linnæus, *Muræna helena*, the European moray, we have then *Muræna* 1. But this Linnæus *helena* obviously is not a species It is a compound of what is now called *Muræna helena*, identifiable from its use at the suppers in honor of Helen in Rome, to which Linnæus refers, and of two other species, one of the old world, one American. *Muræna* 1, therefore includes *Muræna* 50 (—*Gymnothorax moringa*) and *Muræna* 90 (*polyzonia*). But we will use the name *helena* for the Roman moray *Muræna* *Muræna* 2 (*ophis*) is—no one can tell what—a species of *Ophichthus*, and *Muræna* 3 (*serpens*) is the type of the later genus called *Ophisurus* or *Oxystomus* It has very little in common with the morays. Have we gained much by substituting *Muræna* 1, *Muræna* 2 and *Muræna* 3, for *Muræna helena*, *Ophichthus ophis* and *Ophisurus serpens*?

But perhaps it will be best to begin at the bottom of the series The lancelet is the lowest fish, if (1) it is a fish, and (2) if the *Tunicates*, and the *Balanoglossi* are not also fishes If we number the fishes from 1 to 40,000, we shall have to decide beforehand as to the nature of tunicates, lancelets, lampreys, chimæras and sharks as well as that of their various extinct relatives. Apparently the only safe way will be to number the species after another, each in the genus in which it was originally placed In that case, the genus may go where it will, the species will hold their numbers.

In 1774, Pallas named the lancelet, *Limax lanceolatus*. But it is not a *Limax* *Limax* is a land-slug Must we wait till other shell-less snails or *Limax* are numbered, before we can list our first fish Let us chance it as *Limax* 75 and keep it with the fishes if we can

In 1834, Costa named this same lancelet *Branchiostoma lubricum* *Branchiostoma* 1 is therefore equivalent to *Limax* 75 But the species should not be called *lubricum*, but *lanceolatum* This Yarrell recognized in 1836, calling it *Amphioxus lanceolatus*, bringing up the old specific name But his generic name, new and useless, has been the source of much subsequent trouble In any case the species is not *Amphioxus* 1, because it does not start with *Amphioxus*. It was known sixty years before the time of Yarrell

Our next fish is *Branchiostoma caribæum* of Sundevall in 1853 This is a doubtful species, most likely the same as *B lanceolatum*, but it may stand as *Branchiostoma* 2 *Branchiostoma Californiense* Gill 1898 may be *Branchiostoma* 3, and the remaining lancelets are scattered over the world, some recorded as *Amphioxus*, most as *Branchiostoma*

It is not necessary to follow this further. The same conditions prevail throughout zoology The fact is that our present Linnæan system of naming species and groups in zoology or botany is still the best which has been devised or suggested It has the right of way through one hundred and fifty years of usage. All present taxonomy is based upon it. Its embarrassments are due chiefly to the difficulties inherent in the subject, and to the limitations of human nature.

The changes in names of the last thirty years have been, on the whole, in the direction of final stability. The zoologists of the world have devised machinery which will steadily make for permanence, and the necessary period of transition is one from lawlessness to law, from confusion to science In so far as we have confusion this has arisen through neglect or ignorance of law. It can not be remedied by further neglect A writer dealing with scientific names must either call an animal or plant whatever he pleases, or else he must conform to regulations inherent in the nature of his work Arbitrary rules will soon be disregarded The necessary regulations are those which future workers will approve, and we, who are still working in the infancy of taxonomy, must lay foundations on which the future can build

In view of the great issues which depend on accuracy of method, such minor issues as that we rather say *Amphioxus* than *Branchiostoma*, or that it suits us better to call the common eel *Anguilla vulgaris* rather than *Anguilla anguilla*, or that our collection is labeled according to the method of Cuvier, sink into insignificance You can say *Amphioxus* if you like—or *Bdellostoma* We shall know what you mean, but we shall not try to force these names back into nomenclature, replacing older and legitimate names already becoming better known to the actual worker in taxonomy than these names of temporary convenience ever were or ever will be

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THE USE OF SYMBOLS IN ZOOLOGICAL NOMENCLATURE

AT first thought, Dr Needham's suggestion[1] that in substance we designate what are practically subgenera, species and so on, by symbols does give more or less of a shock Never-

[1] SCIENCE, N S., XXXII, pp 295–300, September 2, 1910, see also *ib*, pp 428–429, September 30, 1910, and XXXIII, pp 25–29, January 6, 1911

theless, a little thought certainly shows that some such system as this may be a necessity in the near future and, if for no other reason, should receive earnest attention and discussion The system proposed by Dr Needham has obvious advantages By grouping closely related genera (becoming subgenera) under the old name of the genus when used in its widest sense, two of the fundamental reasons for the existence of nomenclature are reached, namely, stability and ease in identification and in grasping the relations of the various units at a glance But, to my mind, the system has nothing at all to do with stability unless this fundamental change is instituted All will grant, I think, that stability is fundamental, as is also ease or at least possibility of identification I believe, too, that all will concede that neither is possible without what may be called "rigidly" defined genera (=groups), genera which all are willing to rank as such and which all will be able to recognize (perhaps they would be equal to present-day subfamilies at least)

These genera or groups being firmly established by universal acceptance and concise description, then the application of the symbols would doubtless save an immense amount of space Otherwise, I am certainly at a loss to find any other advantages which they may have Synonymy nor anything else is simplified by saying that $5 = 4$ instead of *leucopsallis* = *viridis* The only thing that matters is whether the statement is true or not. You may call 5 anything that you wish without changing what it represents And is it not true that most of our troubles cluster about the fact that we have been unable to find out what authors have meant to represent?

The objections to involved nomenclature entered by the zoologist and biologist are entitled to much consideration, but we should not lose sight of the fact that the present systematic unit—the species—was founded by themselves and seemingly we still find an endless number of them If it is true that they exist it is our duty to keep on recording them. Whether we call them by symbols or names isn't to the point at all. The gist of the matter is, shall the conception of the systematic unit be changed from "natural" species to conceived genera? Will any biologist deny that species exist Why, therefore, should they wish to escape from them? It is true it is impossible to know all of them nor even their names! But who wants to do this The fact that they exist is true, or else our conception, or rather perception, of a species is all wrong Now, if it is true that they exist, I believe that it is necessary that they be represented by names or else symbols. Thus, whether names or symbols are used, either would have to be used an equal number of times, but the symbols would be shorter, that is all It is not the jungle of names that masters us, is it? Rather, is it not the jungle of things? To simplify, natural laws, not symbols, are needed

Therefore, it seems to me that the fundamental plan suggested by Dr Needham, that of falling back upon the old genera and their names, is the only way out of the confusion, present and past As for the symbols, they are preferable only in so far as they have a tendency to simplify, not our knowledge, which they are certainly unable to do here, but our working methods, time and space.

A ARSÈNE GIRAULT

URBANA, ILL,
January 9, 1911

ON FACTORS CONTRIBUTING TO A LOW SCIENTIFIC PRODUCTIVITY IN AMERICA

A FEW months ago I offered some criticisms on a paper by Professor Gunn which appeared in SCIENCE for October 28, 1910, under the caption, "American Educational Defects." My criticisms were directed chiefly to the method adopted by Professor Gunn, and he has very properly retorted[1] that I should not make too much of the matter of method unless I am prepared to dissent from the practical outcome of his study.

Now so far as this outcome was to the effect that the level of scientific and scholarly productivity in this country is unsatisfactory by comparison with that in certain European

[1] SCIENCE, January 20, 1911, N S, XXXIII, 107

countries, I am not prepared to dissent I do indeed believe that Professor Gunn's picture is overdrawn, when he describes our achievements in pure science as "insignificant," for it is easy to point to achievements of very high grade, even in such branches as mathematical physics and philosophy, while of recent years there has appeared a considerable volume of quite respectable work Still, I should admit that the work of very high quality has been too small in amount, and that the volume of recent work suffers somewhat in an appraisal of its quality I should indeed be inclined to make a further reservation on this last point, as far as my own acquaintance with scientific literature goes, for in my own field of experimental psychology, which has hitherto been chiefly cultivated in Germany and in America, I am unable to detect any pronounced superiority of the German work. The Germans do, certainly, manage to give their contributions a more important sound, their articles are more extended, and run out almost indefinitely into discussion and theoretical considerations, but much of this is of little real value, and many an American paper of modest length contains as much of real contribution to knowledge as does its German analogue of a hundred or two hundred pages However, let us freely admit that, when we consider the number of men here who might be expected, from their training and their positions, to be scientific producers, we find the total productivity surprisingly small. There is much to indicate that this is the fact: so numerous are the cases of young men who have produced a creditable doctor's dissertation and obtained a college position in their specialty, but from whom nothing further is heard in the way of original contribution, and so numerous also are the cases of men of proved ability, who, after a few years of activity and after winning a professorship of dignity, allow their output to cease Good minds and good opportunities appear to be going to waste, and the problem of the causes of this condition is one of the highest importance to those who are interested in the advancement of science. It is a problem which deserves treatment by the most painstaking methods of science, unfortunately, I can make no great claims for my own method, for I have by no means conducted researches on the large scale demanded by the complexity of the problem I have, however, for a considerable number of years been keenly interested in this particular problem, and am prepared to adduce a certain number of facts, which, as facts, will scarcely be called in question, and which I shall try to show are probably pertinent

I will first adduce my list of facts, in summary form

1 The economic rewards for scientific production, and punishments for lack of it, have been smaller here than elsewhere

2 Similarly with other social rewards and punishments

3 The rapid expansion of our educational system has created a demand which has absorbed the whole supply of even reasonably qualified men

4 This educational expansion has been but a feature of the general national expansion, and the general demand for men of ability has operated still further to reduce the keenness of academic competition, and so to lower the standard of academic success

5 This rapid expansion, in the presence of our decentralized form of governmental control and generally fluid condition, has made the business of the educational and scientific promoter one of great importance, has operated to give the greatest economic and social prizes to the promoter, and has caused scientific men to spend their time running errands in the interest of science rather than prosecuting their individual research

6 The educational interest, as distinguished from the strictly scientific, has been strong among us, and has led to a considerable deflection of effort from the work of science[3]

[3] There is another probable fact, which I do not include in the list because I am not sure of it, and because it could be determined by suitable inquiry, in advance of which it is best not to guess at the fact The probability is that our young men do not begin to specialize so early as their scientific brethren in Europe, and if this is

Lest I should be accused of altogether neglecting principles in my zeal for facts, I will also mention a few general principles which can properly be employed in reasoning from the above facts

1 The law of supply and demand.

2 The law of the value, as incentives, of rewards and punishments

3 The law of divided energy, according to which a man can not do so much in a given line if his time and energy are largely devoted to something else.

The great fact of rapid expansion is perhaps the most important of all. Since the most obvious feature of this expansion has been that of the economic development of the country and of the growth of industries, the fact is usually hit off as commercial expansion, and the effort made to deduce all our peculiarities and deficiencies from our commercialism But the real fact is expansion, a fact, it is probably of great importance. Our own delay in getting the young man fairly launched on his scientific career is partly due to our superstition that the traditional four years of college marks a minimum of time to be devoted to "general culture," after which, only, should specialization begin Meanwhile, through the raising of the standards for admission to college, the period of specialization has been deferred to about the age of 22 But besides this, it often happens that a man just leaving college and bent on a scholarly career is led to believe that the best step for him next to take is to teach in a secondary school, and thus the age at which he enters on really advanced study is likely to be delayed to 25 From observation of men studying for their doctor's degree, I am convinced that the man who goes straight on from college to the university is usually the one who comes off best in his graduate study The years immediately following the age of 20 are of great value for the ready assimilation of knowledge, and, moreover, the most original period of a man's life is likely to follow close upon these years, and unless he has good command of his specialty by the age of 25 or 27, he is rather unlikely ever to have many original ideas on the subject I am convinced that specialization, for any young man whose bent towards a scholarly pursuit is sufficiently marked to warrant urging him to undertake it, should not be delayed much beyond the age of 20 not commercialism—expansion in all directions A necessary result of this expansion, and a result abundantly in evidence, is that the demand for labor of all kinds, and not least for the labor of intellectually able men, has been great in relation to the supply. The economic reward for intellectual ability has, of course, been much greater in many other lines of work than in the academic, and this has certainly further limited the supply available for scientific pursuits. For example, it has been, and is, difficult to man the laboratory departments of our medical schools, for the reason that the rewards awaiting the successful physician, in practise, have been far in excess of anything he could hope for in research The financial reward for scientific work is everywhere less than the reward for equal accomplishment in other lines; but here this difference is accentuated. In spite of this fact, scholarly pursuits continue to attract a very considerable number of really able men. The men are attracted in part by the freedom of the academic life, in part by the undoubted prestige attaching to good academic positions, and in largest measure, no doubt, by the work itself Improvement of the general economic status of university and college teachers is of course greatly to be desired in the interests of broadening the labor market for this highly important sort of work, but that is by no means the key to the whole situation, for we are confronted with an able body of men, men who have proved, in many cases, their ability in original work, but who nevertheless leave much to be desired in the way of productivity

The expansion of our educational system has, if anything, outstripped our commercial expansion Universities have multiplied and grown enormously, teaching forces have been greatly augmented, and the demand for high-class men to fill academic positions has been ever on the increase The demand has been large in proportion to the supply, so that every moderately equipped candidate has been assured of a post of some dignity. Promotion has been rapid, as far as it goes. In other words, the labor market for all grades of academic work has been relatively narrow, and

there has been an absence of keen competition either for the lower or for the higher positions This is a necessary result of expansion, and, at any rate, it is a fact The conditions, as regards competition, are very different in some European countries A young man there must often serve a long apprenticeship in a very poorly paid position, and can only rise out of this difficult situation by overcoming keen competition Our rather tame discussions of the work of our colleagues lack the keen note of economic competition which is often heard in European controversy Here, we feel, there is room enough for all, and on an approximate equality. Here it makes comparatively little difference to a man, economically, whether his scientific work is mediocre or of eminent success For while the ratio of demand to supply assures him of at least a moderately good position, there is nothing in the way of a very fine position to spur him forward While mediocre men are better off here than in several other countries, very good men, in purely academic positions, are by no means so well off as elsewhere. In Great Britain, at least, there is a considerable number of professorships the financial value of which, when allowance is made for the different purchasing power of money, is fully the equivalent of eight to twelve thousand dollars The financial value of these posts is well known throughout the kingdom, and, as they are permanent establishments, and are filled, when they fall vacant, in the open market, they act as a very effective stimulus to productivity They act as a stimulus to a class of men whom it is most of all important to stimulate, and who, in our country, are subject to no such incentive—namely, to the men of greatest ability, who have already proved their power and have already achieved positions as good as any we have here to offer. Not only a high money value, but also great prestige, attaches to some of these chairs, because of the eminent men who have occupied them in the past. We have practically nothing to correspond to them; and this is, I believe, one of the great deficiencies of our system Nowhere, it would seem, is the punishment for idleness so light as in our academic life, and nowhere is the reward of productive industry so meager I am far from contending that the mere financial reward is the sole stimulus to scientific production, but these prizes not only bring great financial relief, they are also the seal of success I might paraphrase what I said a few sentences back by asserting that nowhere is there such a lack, as in our American academic life, of the tangible symbols of success and failure in scholarly work

To punish mediocrity is scarcely within our power during a period of rapid expansion, but to reward proved merit is in our power Why should not a university, numbering among its professors some one of the acknowledged leaders in American productive scholarship, simply double or triple his salary, at the same time doing all it can to strengthen his department, and thus secure to itself preeminence in that particular subject among all our universities, insuring, further, a continued preeminence by permanently establishing this distinguished chair and this thoroughly equipped department? It should be possible in this way for a university to attract a large share of the best graduate students in this department, and thus add further to the influence of the chief and to the attractiveness of his position. The combined prestige, influence and financial desirability of such a position would make it a prize for the competition of the ablest of the younger men. There is no reason why such prizes should not act as effective spurs here as elsewhere. Our effort has been devoted more to raising the general level of compensation and attractiveness of all professorial positions than to the recognition of eminent scholarly and scientific success. Certainly there is abundant need for raising the general level of salaries to keep pace with the changing ratio between money and other commodities. But the reward of eminent merit is a thing apart

Another consequence of rapid expansion, under the decentralized and rather unorganized conditions of our national activity, in which such an interest as the educational must look out for itself, has been the evolution of

the organizer, agent and promoter. The most striking instance is the university president or chancellor. His function has been distinctly that of the promoter, and so important has this function appeared in a period of expansion that the largest rewards, both pecuniary and in the way of social standing and influence, have gone to the presidency, and some of the ablest and most efficient from the professorial ranks have been drafted into administration. Since the duties of the president have been too exacting to allow a continuance of scholarly work, the result has no doubt been a considerable shrinkage in the volume of possible production. Further, ambitious young professors, observing which way the path of distinction led, have often set themselves to prove their ability in administration rather than in scientific production. Administrative opportunity has abounded throughout the educational system, and many who entered the system from love of science or literature have found their attention largely absorbed by matters of management and promotion. Much of this bustling administrative activity has been a necessary result of expansion, but much of it has been due to mere contagion and mutual emulation. The center of competitive activity has been shifted from scholarship to administration. Now all administrative work, however necessary in the circumstances and however ably performed, is but a means to the ends of scholarship and of education, and it seems a pity that so much of the best brains should go to the means and so little be applied directly to the ends in view. The head of a department, instead of entering his laboratory with the thought of his experiment uppermost in his mind, is first of all oppressed by the condition of his desk. When that is cleared up, he hopes to go ahead with his investigation, but the desk occupies him for so large a part of the day that the experiment is deferred till to-morrow. There is a tremendous dissipation of energy among university professors. We are always busy, but seldom get down to business. We are always busy trying to insure that the work of science be done, and leave little time to do the work ourselves. We are so much occupied in contributing to the advancement of science that we are unable to make contributions to science.

The attention of our scholars has been deflected by educational as well as administrative interests. I am inclined to regard this, too, as a consequence of expansion. For our higher institutions of learning have expanded in faster ratio than the general population, and this means that we are undertaking to educate many who are not specially suited to a higher education. Since the net has been made finer, we are catching many small fish, and the educational problem is largely concerned with these small fish. Whatever be the explanation, there is no doubt of the fact that our university professors are more occupied in the effort to impart instruction and insure that the student derives some benefit from it than is the case in foreign universities. I have heard it said that whenever a group of European university men get together, they talk science, whereas we talk education. We are greatly concerned about the student, and largely about the poor student. This may be best in the circumstances, and I have no desire to attempt a rough and ready solution of so complicated a problem, but simply point out the undoubted fact that here is a factor in our comparative lack of scholarly production. With both the administrative and the educational interests so strong among us, we are prone to hover in the outskirts of scholarship, instead of plunging into the heart of it.

There is another aspect to the whole matter, for the universities are not the sole repositories and organizers of scholarship. Guilds of scholars have to be considered as a means of exciting to productivity. We have, indeed, few productive scholars outside of the universities, though this is at least partly due to the prestige which university professorships have among us, for it would be easy to name a score of scholars and scientific men who, though of independent means, have sought university connections, in order to have a definite standing in the scholarly world. College loyalty has been a strong force among us, and

the attachments of a professor have been mostly to his university rather than to the fellowship of his particular science Of recent years, with the organization of national scientific societies, some change has occurred in this respect It is to guilds of scholars, whether formally organized or not, that we must look for setting the standard of scholarly production The fellowship of scholars can only be a matter of gradual development, and their standards also must grow and can not be suddenly and artificially raised, but there is plenty of evidence that the standards of our scholarly guilds have been rapidly improving, and they will probably continue to improve Such guilds possess rewards and punishments of their own, for the standing of a man among his fellows is one of the strongest incentives to action The standards of the guilds must eventually be the standards of the universities, and thus we hold in our own hands, quite apart from the momentary attitude of university authorities, a force capable of raising the level of our own work and that of our successors

R S WOODWORTH

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BIOLOGICAL TEACHING IN SECONDARY SCHOOLS

A MEETING of men interested in the advancement of biological teaching in secondary schools was held at the Harvard Union, Cambridge, on Saturday, February 4 Those present were Professor G H Parker, Harvard University; Principal Irving O Palmer, Newton Technical High School, Dr H R Linville, Jamaica (N. Y) High School, R H Howe, Jr, Middlesex School, Samuel F Tower, Boston English High School, S Warren Sturgis, Groton School, Head Master Frank E Lane and W L W Field, Milton Academy The relation of school biology to civics, the sequence of laboratory experiments, outdoor work with classes and college requirements were the topics informally discussed. The undersigned was authorized to communicate with other teachers with a view to establishing a series of conferences, perhaps to be held alternately in Boston and New York. Correspondence is accordingly invited from interested readers of this notice

W L W FIELD

MILTON ACADEMY,
MILTON, MASS,
February 6, 1911

SCIENTIFIC BOOKS

Questioned Documents A Study of Questioned Documents with an Outline of Methods by which the Facts may be Discovered and Shown By ALBERT S OSBORN With an Introduction by Professor JOHN H WIGMORE Two hundred illustrations Rochester, N. Y, The Lawyers' Cooperative Publishing Co 1910 Pp xxiv+501

"Questioned Documents" is an admirably clear presentation of the application by experts of modern scientific methods to the study of handwriting It gives a detailed exposition of the use in the identification of handwriting of enlarged photographs taken in various lights, of the document microscope and of the color microscope designed for recording the tints and shades of ink The instruments and appliances used in getting accurate measurements of such details of writing as the width of the line-stroke and the slant of various parts are also described Particularly interesting is the suggestion of the new application of stereoscopic photography in such a way as to determine in disputed handwriting the sequence of crossed lines, the time-relation of writing to folds in paper and the presence of erasures and changes in paper-fiber

The purpose of the book is practical—a very successful attempt to present the science of handwriting in relation to law, an attempt which constitutes a new and profitable departure in legal literature The author would arouse the interest of the trial lawyer in, and his intelligent comprehension of, the problems involved in questioned documents, so that he may be better qualified to deal with situations involving such matters. Those interested in the pure science of handwriting will, none the less, find much to learn from the author relative to its accurate measurement and analysis The reviewer is acquainted with no other

treatment of the subject from the practical standpoint as thoroughgoing and suggestive.

Since the psychology of individual variation in handwriting characteristics is still an unwritten chapter of the science, it is not surprising that the analysis of handwriting habits in the volume under consideration should be largely in terms of the writing system learned by the penman and of the writing instruments and material utilized by him. Such an analysis is accompanied by an historical account of the rise of various systems of handwriting and by a description of their characteristics. The dependence of many peculiarities of writing, such, for example, as shading, upon pen position, should be noted by the investigator of the subject. The author insists upon the use of a sufficient amount of proved handwriting as a standard for comparison in the case of a disputed document and records instances of normal variation in handwriting in such a way as to show forgery by a tracing-process in the case of unnatural uniformity. The interesting observation is made that individual writing habits are found to be revealed more clearly in minor details than in striking features, such as large capital forms. Possibly the author might, with profit, have treated at greater length variations in handwriting due to age, disease and emotional disturbance.

The author insists that the testimony of the handwriting expert should, if acceptable, be the expression not of an opinion founded upon more or less vague intuitions, but of a scientific conclusion from facts, a conclusion based upon reasons which are intelligible to the non-expert and presentable in court. The author is sceptical of testimony that concerns itself with the general appearance of handwriting rather than with accurate analysis and measurement. He is, naturally, amused by the pretensions of the graphologists who would read from handwriting the physical characteristics of the penman and catalogue therefrom his vices and virtues.

The application by the author of the methods used in identification of handwriting to the study of questioned typewriting shows a new field of inquiry, one that appears well worth working by the expert.

June E. Downey

University of Wyoming

Tables for the Determination of Common Rocks. By Oliver Bowles, M.A., Instructor in Geology and Mineralogy, University of Minnesota. 16mo. Pp. vii + 64. New York, D. Van Nostrand & Co. 1910. $0.50.

This text is designed to meet the need of suitable tables for the determination of rocks and rock-forming minerals by microscopic methods and constitutes a convenient and useful pocket guide for field and laboratory purposes.

The usual classification of rocks is given but no attempt is made to group them in the tables accordingly. The grouping, based upon texture, is I., Glassy, II., Ashy or Cellular, III., Crystalline, even grained, IV., Porphyritic, V., Dense and Finegrained, VI., Banded, VII., Fragmental. The various types are arranged in the proper group and described briefly. In the case of crystalline rocks, mineral composition is made a basis for further subdivision and one chapter is given to tables for the determination of the more common rock-forming minerals, the classification being based upon color, hardness and cleavage.

The last chapter contains a short discussion of building stones. Terms used in the text are amply defined in a glossary at the end of the book.

R. W. Clark

Mineralogical Laboratory,
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SCIENTIFIC JOURNALS AND ARTICLES

The contents of the *American Journal of Science* for March are:

"Transmission of Light through Transparent Inactive Crystal Plates, with Special Reference to Observations in Convergent Polarized Light," F. E. Wright.

"Separation and Estimation of Barium Associated with Calcium and Magnesium, by the Action of Acetyl Chloride in Acetone upon the Mixed Chlorides," F. A. Gooch and C. N. Boynton.

"Feldspar Aggregate Occurring in Nelson County, Virginia," W M Thornton, Jr

"History of the Coconut Palm in America," O F Cook

"New Mink from the Shell Heaps of Maine," F B Loomis

THE first number of the new journal, *Phytopathology,* has just appeared This periodical is the official organ of the American Phytopathological Society It is to be published bimonthly and to be devoted to both the purely scientific and practical economic features of plant disease investigations The chief editors are Dr L R Jones, professor of plant pathology, University of Wisconsin, Dr C L Shear, plant pathologist, U S Department of Agriculture, and Professor H. H Whetzel, professor of plant pathology, Cornell University, who are assisted by twelve associate editors, representing different institutions and sections of the country The initial number contains 37 pages and 6 plates An excellent portrait of Anton de Bary, hitherto unpublished, appears in the frontispiece The following articles are included

"Anton de Bary" (with portrait), Erwin F Smith

"The Rusts of White and Red Clover," Frank D Kern

"Crown Gall of Plants," Erwin F Smith

"Fig Diseases," C. W Edgerton

"Floret Sterility of Wheats in the Southwest," Edw C Johnson

"Black leg or Phoma Wilt of Cabbage," Thos F Manns

"A New Fruit Spot of Apple," W M Scott

Reviews

SPECIAL ARTICLES

A KINETIC THEORY OF GRAVITATION[1]

EVER since Sir Isaac Newton enunciated the law of universal gravitation, more than two hundred years ago, philosophers have speculated on the nature of the mysterious agency which links every atom of matter in the universe with every other atom. Newton was unable to offer any adequate explanation.

Since Newton's time several theories of gravitation have been proposed, but all, of which I am aware, are open to strong objections and are not considered even promising by physicists

Study of the nature of gravitation is beset with unusual difficulties, because gravitation is ever with us and about us, it is the one universal phenomenon, and we can not escape from its influence—can not obtain any outside point of view

Gravitation is often described as a feeble force, and so it is, from one point of view It is difficult to measure, or even to detect, attraction between two small bodies But when the bodies are of planetary size the aggregate attraction of their molecules is enormous It is easy to calculate that the attraction between the earth and the moon, which is just sufficient to retain the latter in its orbit, would, if replaced by a steel cable, require that the cable be about five hundred miles in diameter in order to withstand the strain Between the earth and sun, the cable would have to be nearly as large in diameter as the earth, and attraction between the components of some double stars is millions of times greater than between the earth and sun (Lodge) So tremendous a phenomenon as gravitation, a phenomenon compared with which all others seem trivial, must have a mighty origin

That gravitation is a phenomenon of the all-pervading ether is beyond reasonable doubt This is so generally conceded that it need not be argued But how does the gravitative influence originate? how is it transmitted and maintained? what is the *mechanism* of gravitation? It is the purpose of this paper to attempt an answer to these questions

Let us consider what happens to a falling body We know that it gathers kinetic energy from some source, as evidenced by its acceleration; that this energy may do external work or develop heat, that the amount of energy gathered is measured directly by the distance fallen through (within the limits of uniform gravitation), irrespective of the time or rate of falling. When the distance fallen through is of inter-planetary magnitude, and the attracting body large, the gathered energy

[1] Read before the American Association for the Advancement of Science, December, 1910.

is enormous, sufficient, if converted into heat, to vaporize the most refractory falling body.

We are here confronted with the question, whence comes the energy acquired by a falling body? Certainly it was not inherent in the body before the fall, as evidenced by the fact that during unimpeded fall none of the physical or chemical attributes of the body, aside from the acquired motion, changes in the slightest degree.

We have been taught that before the fall the body was endowed with "potential energy of position," which is converted into kinetic energy during the fall. I think "energy of position" is an unfortunate term because it is so very inadequate. To me, it explains nothing. The case is not like that of a flexed spring, where there is internal molecular strain or displacement.

Let us imagine a pound-weight of iron, for instance, raised from the surface of the earth to a point near the moon, in a line joining the centers of the two bodies, the point so chosen that the opposing attraction of the earth and the moon shall exactly balance each other, leaving orbital motion out of consideration.

On the surface of the earth the pound-weight had some so-called "potential energy of position" because it was capable of falling into a pit, but in its new position near the moon, this potential energy not only has not been augmented, but has disappeared entirely, the pound-weight, left free to move, remains stationary. And yet we must have expended more than twenty million foot-pounds of energy in overcoming the attraction of the earth and lifting the weight to its new position. This amount of energy would be sufficient to impart to the weight a velocity more than ten times greater than that of the swiftest cannon ball, or, if converted into heat, would be many times more than sufficient to raise the iron weight to dazzling incandescence and then vaporize it. Now, in lifting the weight, this large amount of energy has disappeared utterly. We can not believe that the whole or any part of it has been annihilated; it must, in some form, be resident somewhere. I think no one will contend that this energy is resident, in any form, in the cold, motionless pound-weight. I believe it was absorbed by, and is now resident in, the ether through which the weight was raised. Conversely, if this be true, a falling body must acquire its energy from the ether through which it falls. This is a fundamental idea to which I invite attention. Faraday glimpsed it long ago, and others have appreciated it more clearly since his time. But, so far as I am aware, no one has realized its significance.

This view of gravitation implies that the ether is endowed with very great intrinsic energy in some form. Many scientists now hold that the ether is so endowed, and that the amount of this intrinsic energy is enormous. Sir Oliver Lodge[3] appears to regard this energy as potential in form, and estimates the intrinsic energy of a single cubic millimeter of the ether to be almost inconceivably vast. He says, "All potential energy exists in the ether." Sir J. J. Thomson says, "All kinetic energy is kinetic energy of the ether."

I conceive the ethereal energy involved in gravitation to be kinetic rather than potential, the latter involving strain or stress. Newton, and later Maxwell, assumed that bodies produce a stress in the ether about them, of such nature as to account for gravitation, but they were unable to imagine any physical cause for the stress.

All the past theories of gravitation of which I am aware, except the corpuscular theory of La Sage, appear to regard gravitating matter as the seat of the gravitative influence, the surrounding ether, by induced stress or otherwise, acting simply as the medium of transmission. I can not see that any of these theories accounts for the energy acquired by a falling body.

My own view of gravitation differs from these radically. I believe that kinetic energy of the ether is the fundamental cause of gravitation, and that a gravitating body plays a secondary rôle only, in disturbing the normally uniform distribution of the ether's energy, in a manner I shall endeavor to explain later.

[3] "The Ether of Space."

Let us assume, then, that the ether is endowed with very great kinetic energy normally uniform in distribution

Kinetic energy implies motion of something possessed of inertia Now, inertia is a fundamental attribute of the ether Sir J J Thomson holds that all inertia is inertia of the ether. The ether is highly elastic also, which, with its inertia, enables it to possess kinetic energy in wave form, as exemplified in radiation By the term wave, I mean progressive motion locally periodic, doubtless the ether as a whole is stationary Hence we may consider the kinetic energy of the ether as consisting in ether waves of some kind

These waves, vast in aggregate energy, eternal in persistence, without finite source or destination, are imagined as being propagated in straight lines in every conceivable direction This isotropic distribution of kinetic energy, essential to my theory of gravitation, was, for me, a difficult conception until I reflected that isotropic radiant energy is approximately realized in the interior of any furnace with uniformly heated walls

Any kind of waves capable of exerting motive action on the atoms or molecules of matter will fulfil the requirements, but I shall first consider the transverse, electromagnetic waves of radiation because these are the kind of ether waves we are familiar with

Of course intrinsic ether waves, if of the radiation kind, can not be of any frequency at present known to us as radiation, because then all bodies would become heated But we can easily imagine them of such extremely low frequency that the molecules or atoms of matter can not respond to them—can not vibrate in unison with them—molecular resonance can not be established, hence no conversion of the ether energy *directly* into heat in the ordinary way can take place

We are familiar with the dissipation or degeneration of the higher forms of energy into heat, and the continual degradation of heat to lower degree; that is to say, less violent molecular vibration and more general distribution As is well known, it is only through this degradation or running down of natural energy that we are enabled to utilize some of it Lord Kelvin called this function of energy "motivity" (we now call it entropy), and said the motivity of the universe tends to zero

We know that ordinary radiation waves in the ether persist indefinitely and without change of frequency or direction until they encounter matter, when they are absorbed and converted into heat, only to be radiated again, usually in longer waves, to some colder body This degradation of wave frequency continues until we can no longer follow it I beg to suggest that the ultimate destination of this wave energy is that vast reservoir of kinetic energy intrinsic to the ether We may liken the waves of radiant energy, which we apprehend as light and heat, to wind ripples on the surface of water, which continually degenerate in wave frequency until they are absorbed into and become a part of the mighty swell of the ocean.

Thus we may, perhaps, regard the ether's intrinsic energy as energy in its lowest form —Kelvin's zero of "motivity" But fortunately we may and do get some of this energy back in available form in several ways, as, for instance, when a falling body is arrested and develops heat, some of our wind ripples are then returned to us

When two gigantic astronomical bodies collide under the influence of gravitation, as sometimes happens, we witness in far distant space the birth of a nebula The inconceivably vast amount of heat developed by the collision converts both bodies into luminous vapor which expands with incredible rapidity into the nebulous cloud. This heat energy must in course of time degenerate back into the ether whence it came, though billions of years may be required, and during all this time the energy has "motivity" We may picture the stupendous result of the collision as only a local splash in the ether's mighty ocean of energy

Having postulated that the ether is endowed with very great intrinsic kinetic energy in wave form of some kind, that the waves are

propagated in straight lines in every conceivable direction, *i. e.*, the wave energy is isotropic, and that this energy is distributed uniformly throughout the universe except in so far as the distribution is disturbed by the presence of matter, I shall endeavor to explain my conception of the mechanism of gravitation.

For illustration in terms of the known, let us imagine a closed space having uniformly luminous walls of such character that every point on their surface radiates light in all internal directions. The enclosed space may be of any shape, but for the sake of simplicity let it be spherical or cubical, and large, say as large as a lecture room The space will be filled with isotropic radiant energy uniformly distributed—any cubic centimeter of space containing as much energy as any other

Next let us picture a small opaque body suspended anywhere in our luminous space The body may be of any shape we may imagine an atom or molecule to have, but, again for simplicity, let it be spherical—say a small grain of shot, and let it be located near the center of the space

The small body will absorb the light which falls upon it and will cast a spherical shadow, the depth or intensity of which will vary inversely with the square of the distance from the center of the body; and the shadow will extend to the confines of the enclosure, however large the latter may be. We can not perceive the shadow, but we know it is there. It is true that the body will soon acquire the temperature of its surroundings, and radiate as much energy as it receives, but for the purpose of this illustration let us consider only the high-frequency light energy.

As is well known, the ether waves of light will exert a slight pressure on the body. But in the case supposed, the pressure will be equal on all sides and no effort toward translation can result

Now let us introduce a second small body, similar to the first, and some distance from it. This, also, will cast a spherical shadow like the first. The two shadows will intersect, and each body will lie within the shadow of the other In other words, each body will be partially shielded by the other from the ether waves coming from that direction. Hence the light pressure will be less on that side of each body which faces toward the other than on the side which is turned away, and the bodies will be urged toward each other by the excess of light pressure on the sides turned away. This excess of pressure will vary with the inverse square of the distance between the centers of the bodies so long as the ratio of distance to diameters remains large

The ether waves concerned in gravitation can not, however, be like the light-waves I have just used for illustration, because light-waves heat bodies on which they fall, and their pressure is almost wholly superficial, it does not reach molecules much below the surface, and hence bears little relation to mass

But let us substitute for the short and feeble waves of light, powerful waves, still of the radiant kind, but of such great length and slow frequency that, as before explained, they do not excite the molecular vibrations which we appreciate as heat, and hence are not absorbed by matter, they pass freely through all bodies, bathing the interior molecules as effectually as those on the surface

Under these conditions each molecule or atom or unit of a gravitating body will have its own spherical shadow or field of influence, and the gravitative force acting on the body will vary directly with the sum of its units, *i. e.*, with its mass

The spherical shadow which I have pictured as the field of influence of each atom or material unit implies that the atom has caused, principally in its immediate neighborhood, a diminution of the ether's energy. Let us further imagine this subtracted energy resident in the atom as kinetic energy of translation in many paths, almost infinitesimally short and in every direction, but without collisions because neighboring atoms follow *very* nearly parallel paths We may then picture the collective atoms or molecules of matter buffeted about in every direction by the ether waves in which they are entangled, like a suspended precipitate in turbulent water.

Each atom or molecule may be regarded as a center of activity due to its kinetic energy of translation, with continual absorption and restitution of the ether's energy, normally equal in amount The manner in which this molecular activity maintains, in effect, the supposed spherical shadow requires explanation which I shall attempt in a future paper

Of the several components into which the composite motion of each atom can be resolved, that one lying in the direction of an attracting body will be the greatest, because the waves from that direction, being partially intercepted by the attracting body, are weakest; and the atom will be *pushed* in that direction by the superior waves behind it If free to fall, the atom will continually absorb more energy from the stronger waves behind it than it restores to the weaker waves in front, and will thus acquire additional kinetic energy of translation in the line of fall, measured directly by the number of waves involved, *i e*, by the distance moved Conversely, if the atom be forced away from the attracting body, restitution of energy will exceed absorption, and the energy expended in moving the atom against attraction will be transferred to the ether

It will be seen that gravitation is a *push* toward the attracting body, and not a pull It is clear, also, that the velocity which a falling body can acquire tends asymptotically to a limit, which is the velocity of the ether waves which push it—the velocity of light, if transverse waves are involved.

I have already intimated that any kind of ether waves capable of imparting motion (not internal vibration) to the atoms of matter will fulfil the requirements of my theory, but have thus far discussed only transverse waves.

Let us now consider longitudinal waves—waves of compression and rarefaction, like sound waves in air and in elastic liquids and solids The "spherical shadow" conception which I have employed in connection with transverse waves applies equally well here

So far as I am aware, longitudinal waves in the ether are unknown, but that such waves have not been observed is not convincing argument that they do not exist

Assuming then that some, or perhaps much, of the intrinsic energy of the ether is embodied in longitudinal waves, we have only to find some motive action of such waves on atoms of matter to account for gravitation Adequate motive connection may perhaps be effected by the locally alternating flow and ebb—acceleration and retardation of the ether in which the atoms are enmeshed, incident to its wave motion We have ample reason for believing that the ether does obtain a grip of some sort on the atoms of an accelerating (falling) body, and a retarding (rising) body, from which it follows that accelerating and retarding ether, as in a wave of compression, must grip a comparatively stationary atom

Certain facts of astronomy apparently require that gravitational attraction between bodies, however distant from each other, must, in effect, be instantaneous, that is to say, the line of apparent attraction between them is a straight line joining their centers I believe my theory meets this condition, but I shall reserve discussion of the point for a future paper

I feel much diffidence in presenting the foregoing rough draft of a theory of gravitation, but I can not avoid the belief that it contains some germs of truth, perhaps the real key to the great mystery, though, if this be true, I have, no doubt, used the key clumsily and imperfectly

If the ether-wave theory of gravitation is, in the main, the true one, it offers some hope of experimental verification. Provided the waves are of one principal frequency, or even of several, we may find something, doubtless of molecular magnitude only, which will oscillate in unison with them so that resonance can occasionally be established and a cumulative effect obtained sufficient to manifest itself as heat

In searching for some natural phenomenon of this nature, I thought of the thermal condition of the upper atmosphere as a possible case. The mean molecular velocity of a gas at some temperature, in connection with the

mean free path of its molecules at some particular pressure or pressures, may possibly afford the necessary conditions for fortuitous resonance, with development of some slight amount of heat by the increased violence of inter-molecular collisions I have done much experimental work on these lines during the past year, but, notwithstanding refinement of method and manipulation, the results have thus far been unsatisfactory The work is still in progress, however, and investigation of other phenomena is contemplated

CHARLES F BRUSH

CLEVELAND, OHIO

AMERICAN SOCIETY OF ZOOLOGISTS EASTERN BRANCH

THE Eastern Branch of the American Society of Zoologists held its annual meeting on December 27-30, 1910, inclusive, at Cornell University, Ithaca, N Y, in conjunction with the American Society of Naturalists, the American Association of Anatomists and the Society of American Bacteriologists

The following officers were elected

President—H V Wilson, University of North Carolina.

Vice president—H E Crampton, Columbia University

Secretary treasurer—Raymond Pearl, Maine Agricultural Experiment Station

Additional Member of Executive Committee—R G Harrison, Yale University

The following persons were elected members of the American Society of Zoologists at this meeting Dr Alice M Boring, University of Maine, Dr O A Johannsen, Maine Agricultural Experiment Station, Professor R E Sheldon, University of Pittsburgh, Professor A E Lambert, State Normal School, Framingham, Mass, Dr R C Schiedt, Franklin and Marshall College, Dr Sergius Morgulis, Harvard University, Professor E W Gudger, State Normal College, Greensboro, N C, Dr A M Banta, Carnegie Institution, Station for Experimental Evolution, Professor G G Scott, College of the City of New York

A committee was appointed to prepare a resolution on the death of Professor C O Whitman This resolution will be published in a later number of SCIENCE

The following papers were presented at the meeting, either in full, or by title

The Spermatogenesis of the Opossum· H E JORDAN, University of Virginia.

An accessory chromosome and chondriosomes are the structures of special interest Metaphase plates of dividing spermatogonia contain 17 rod-shaped chromosomes (diploid group, 16 autosomes, 1 monosome) A chromatin- (chromosome) nucleolus is present during the growth period (including synizesis and synapsis) invariably at that point near the nuclear membrane next the centrosphere The first numerical reduction results from a pairing end to end (telosynapsis) of the 16 autosomes The haploid chromosome group thus contains 9, the accessory recognizable by its larger size and bipartite form During metakinesis (reduction division) the accessory chromosome passes undivided, and in advance of the ordinary chromosomes, to one pole Two types of secondary spermatocytes result one with 9, the other with 8 chromosomes During the brief resting phase one type has a chromatin nucleolus, the other lacks this structure A second numerical reduction has occurred—a phenomenon, previously described by Bardeleben (1898) for man, and quite recently by Guyer for certain birds—giving rise to hemioid groups containing 5 and 4 chromosomes, respectively The ensuing division is equational In the early spermatid-phase a resolution takes place giving 9 and 8 chromosomes, respectively A dimorphism of spermatozoa thus results Chondriosomes (mitochondria) appear in early postsynaptic stages (probably as chromidia passed out of the nucleus) A direct continuity is demonstrable between the chondriosomes and the spiral filament of the middle piece of the spermatozoon No twin spermatozoa, such as Selenka described in the vas deferens of the opossum, appear in the testis studied

The complete paper will appear in the *Archiv für Zellforschung*

The Germ Cell Determinants of Beetles' Eggs ROBERT W HEGNER, University of Michigan

This report is based on the results of experiments in killing parts of the eggs of some chrysomelid beetles The posterior ends of freshly-laid eggs contain a disc shaped mass of granules that stain like chromatin. These granules are taken up by the cleavage products that encounter them, these cleavage products later become germ cells For this reason the granules have been called germ cell determinants When the posterior ends of freshly-laid eggs are killed with a hot needle, thus preventing the granules from taking part in

development, the resulting embryos do not develop germ cells. This evidence strengthens the hypothesis that these granules are really germ cell determinants.

The complete paper will be published in the *Biological Bulletin*.

Heterochromosomes in Mosquitoes: N. M. STEVENS, Bryn Mawr College.

An unequal pair of heterochromosomes is found in the male germ cells of *Anopheles punctipennis*, and the heterochromosome differentiation can be seen in the resting spermatogonia and in the spermatids as well as in the spermatocytes. In *Culex pipiens*, *Culex tarsalis* and *Theobaldia incidens* no such differentiation of heterochromosomes is present. As the sex determining mechanism is without doubt the same in the several species of mosquitoes, it is evident that heterochromosome differentiation is not a necessary factor in the determination of sex. In *Culex* and *Theobaldia* we certainly can not say two X chromosomes give a female and one X chromosome or an X and a Y chromosome give a male, for there are no X or Y chromosomes. However, it is evident that, although the heterochromosome differentiation may have nothing to do with sex-determination, the sex determining factors must be closely correlated with it, and may in some cases be located in the heterochromosomes. The importance of a study of the origin and history of the heterochromosomes apart from the idea of sex determination is urged. The complete paper will be published in the *Biological Bulletin*.

Origin and Significance of Mitochondria: T. H. MONTGOMERY, JR., University of Pennsylvania.

(An excerpt from a paper to be published in the *Journal of Morphology* on the spermatogenesis of *Euschistus*.)

The mitochondria undergo their chief growth and multiplication in the growth period of the germ cells, and are few or absent in the spermatogonia. Their mode of division in the reduction mitoses is irregular, and they become divided by the cell constriction. They do not arise as eliminated chromatin nor from the allosomes, but apparently as a chemical interaction of nucleus and idiosome. They represent part of the epigenetic history of the germ cells, and the chromosomes the preformistic.

The Method of Cell Division in Moniezia: A. RICHARDS, Princeton University. (Introduced by Ulric Dahlgren.)

A reinvestigation of the development of the female sex products of *Moniezia* has not substantiated the claim of Child that amitosis has a regular place in this development. Amitotic divisions were found at no stage in the growth of these products. On the other hand, mitoses occur at all stages in the development, although more rarely in the early oogenesis than might have been expected. Probably also periodicity of mitotic divisions is one reason for the relative scarcity of spindles at this stage. Cleavage divisions are positively mitotic for the spindle in each cell generation may be found. The complete paper will appear in the *Biological Bulletin*.

The Relation between the Formation of the Fertilization Membrane and the Initiation of the Development of the Echinoderm Egg: J. F. MCCLENDON, Cornell University Medical College.

Loeb observed that the sea urchin's egg may develop without the formation of a fertilization membrane, and I have confirmed this observation, and shown that Harvey is very probably wrong in his supposition that this is a case of failure in "pushing out" of the membrane. Therefore I concluded that "membrane formation" is not essential for the segmentation of the egg, although by furnishing protection it may insure the development of the embryo.

Loeb postulated that an osmotically active colloid exists in the unfertilized egg, but is so covered with lipoids that it does not absorb water until it is squeezed out or otherwise exposed at the surface of the egg, at the beginning of development (when it fills the so called "perivitelline space"). I have shown[1] that this substance bears a positive charge (is basic) since it migrates toward the kathode when an electric current is passed through sea water containing the fertilized egg.

The unfertilized egg is imbedded in a mass of jelly which is probably mucin. This jelly bears a negative charge (is acid) since it combines with color bases.

When the positively charged colloid is exposed at the surface and comes in contact with the negatively charged jelly, the two mutually precipitate at their surface of contact, thus forming the fertilization membrane. But if all of the jelly is washed off of the egg before the latter is caused to develop, no fertilization membrane is formed (as I have observed) because no two oppo-

[1] *Am. Jour. Physiol.*, 1910, XXVII., 240.

sitely charged colloids are brought in contact, but the basic colloid may with difficulty be seen as a refractive layer, which has been mistaken for a poorly developed "fertilization membrane."

The increased permeability of the egg surface, which releases the basic colloid, is one of the prerequisites to the increased oxidation of the developing egg, and in this way membrane formation and development are induced by the same change.

Evidence for the Transmission of the "Wound Stimulus" to Underlying Tissues and its Relation to Regeneration: J. F. McClendon, Cornell University Medical College.

The "current of injury" produced by the negative electric potential of a wounded surface is common to animal and plant tissues. The wounded cell acts as an electric generator and a current flows through neighboring cells. If a current is passed through living tissue, which is subsequently fixed and stained, basophile substances will be found displaced toward the anode. In sections of tissue adjacent to a wound the extent of the current is indicated by the displacement of basophile granules. The current affects first the cells in contact with the wounded cells, then extends in some directions more than others. Electric currents (currents of growth) continue for many days after the wound has healed. Since electric currents cause sea urchin eggs and tissue cells to divide and proliferate, probably these bioelectric currents constitute the so-called "formative stimulus" of regeneration.

Maturing Reagents and those Inducing Segmentation in Artificial Parthenogenesis: Max Withrow Morse, Trinity College.

An extended series of experiments, continued throughout the summer at the Harpswell Laboratory upon the eggs of *Cerebratulus*, demonstrated that those reagents which induced maturation of this egg, would not cause development to proceed farther through the segmentation stages and indeed evidence for an inhibiting action to segmentation on the part of the solutions used in causing the egg to throw off the polar bodies, was obtained. The glucoside saponin, dibasic acids such as oxalic, hydrochloric and tartaric acid were used successfully to mature the egg, but no subsequent application of these reagents caused segmentation to proceed. It was found, however, that if every trace of these solutions was removed by careful washing and the eggs placed in a CO_2 sea water solution, with a concentration of approximately 0.19 g. to the 100 g. sea water, segmentation proceeded. However, no method was found whereby the eggs could be carried beyond the later segmentation stages. Loeb and others have observed this antagonistic action of maturing and segmentation-producing reagents in other forms, and in such cases, as in the present one, the reactions are not reversible, CO_2 will not cause maturation. The experiments were checked against temperature, salinity, alkalinity and such external factors as might modify results.

Newly Found Odonate Larvæ of Special Interest from Costa Rica: P. P. Calvert, University of Pennsylvania.

The larva of *Cora* possesses two-branched mandibles, and paired ventral tracheal gills (= modified legs?) on abdominal segments 2–7, in addition to three thick caudal tracheal gills. A detailed account has appeared in *Entomological News* for February, 1911.

The larva of *Mecistogaster modestus* lives in the rain water between the leaf bases of arboricolous bromeliads. The remarkable increase in length at transformation, from the larva measuring 24 mm. long to the adult 82 mm. long, occupying about one and a half hours, was illustrated by a series of lantern slides from life. The full description will probably be published in the journal quoted above.

The Chondrocranium of Eumeces (preliminary report): Edward L. Rice, Ohio Wesleyan University.

Preliminary comparison with chondrocranium of *Lacerta* as described by Gaupp. For most part these skulls are very similar, but with some striking differences. Particularly striking is enormous size in *Eumeces* of pars cochlearis of otic capsule. This extends far down into region of basal plate, displacing facialis foramen relatively upward between the two parts of otic capsule.

In no single stage is lateral wall of temporal region so complete as in *Lacerta*, although all the same elements may be recognized in a comparison of various stages, some parts being in regression while others are progressively developing. In earliest stages tænia parietalis media extends upward and backward to unite with tænia marginalis, thus dividing fenestra prootica into upper and lower portions, latter furnishing exit for trigeminal nerve.

Cartilage of interorbital septum continuous in younger specimens; progressively fenestrated in later stages.

Nasal capsule in general less complete than in

Lacerta, but large fenestra lateralis nasi, emphasized by Gaupp, wanting in all stages

Considerable individual variation in arrangement of nerve foramina Without reference to age, hypoglossus foramina may be either three or two on each side, or three on one side and two on other Also irregularities in course of abducens

Discussion of columella auris deferred

The Taxonomic Value of the Brain B G WILDER, Cornell University

That the brain presents distinctive characters in certain teleostean families was claimed by L Agassiz in 1844[1] The taxonomic value of encephalic characters has been maintained at different times by Owen, Gill and the writer Nevertheless, recent revisions of various groups do not even mention the brain, and four years ago a review[2] by a former secretary and vice-president of the zoologic section of the American Association for the Advancement of Science declares that the study of the nervous system has no value from any other point of view than that of function The present paper mentioned instances of generally accepted groupings that might have been based upon the brain alone, recalled malassignments (*e g*, of the Sirenia with the Cetacea, of ganoids and selachians as *Palæichthyes*) that might have been averted by due consideration of the brain; and held that such consideration forbade the association of ganoids and dipnoans as a "ganoid dipnoan phylum," warranted the separation of lampreys and hags as coordinate groups of class grade, and showed that *Pristiophorus* is a primitive type not nearly related to *Pristis* Standard treatises evince indifference toward the brain or ignorance of it, and are open to criticisms comparable with those in the *American Journal of Science*, Vol 20, July, 1880, p 76, likewise the commingling of constant and peculiar characters with others not really distinctive, as deprecated in 1885[4] and in 1894[5]

The Histology of the Oviduct of the Domestic Fowl FRANK M SURFACE, Kentucky Agricultural Experiment Station

This paper will be published in the Annual Report of the Maine Agricultural Experiment Station for 1911

[1] *Bull. Soc. Sci. Nat Neuchatel*, December 4, p 147

[2] SCIENCE, Vol XXIV, p 646

[4] SCIENCE, Vol VI, p. 223, September 11.

[5] *Asso Amer Anat*, *Proceedings*, 7th session, p 19

The Lampreys of the Cayuga Lake Basin Fate of Lampreys after Spawning, Non-parasitism of the Brook Lamprey SIMON H GAGE, Cornell University

After spawning, lake lampreys were put into wire cages with live cat fish The cages were kept in the running water of the stream where they spawned, and in the lake water at the Limnological Station The spent lampreys never fed upon the cat fish, and soon died Dead bodies of lampreys were found in great abundance along the stream The discovery was made that the notochord is very persistent, enduring in full perfection after all the rest of the animal had decayed There seems great probability that under favorable conditions the notochords might become fossilized, if so they would puzzle the paleontologist.

The non parasitism of the brook lamprey was first reported by me in 1898 The demonstration has been repeated during the years 1907, 1908 and 1909, by keeping the transforming animals over winter in an aquarium They live under the sand like the ammocœte, and only emerge in the spring when their sexual products are ripe Lake lampreys when they transform attack fish with great ferocity, and suck their blood, but the brook lamprey never attacks fish under the most favorable conditions When they emerge from the sand they lay their eggs and die From their structural adaptation to parasitism it is believed that they were once parasitic, but have lost that habit

Protective Coloration in Poultry RAYMOND PEARL, Maine Agricultural Experiment Station

This paper has appeared in the *American Naturalist* for February, 1911, under the title "Data on the Relative Conspicuousness of Barred and Self colored Fowls"

Adaptive Color Changes in Flounders. F B SUMNER, U S Bureau of Fisheries.

The author described the results of some inquiries, conducted at Naples and Woods Hole, into the relation between the visible background and the color shade and pigment-pattern assumed by the fish

Sense of Smell in Selachians. R. E. SHELDON, University of Pittsburgh (Introduced by S H. Gage.)

1 A current of water, caused by the respiratory movements, and augmented by the forward motion of the fish in swimming, courses through the nasal capsules of the dogfish

2. By this means substances in solution in the water come in contact with the olfactory mucous membrane.

3. Dogfish recognize and determine the location of food substances through a chemical sense.

4. This power is lost when the olfactory capsules are filled with loose cotton. It is regained when the cotton is removed.

5. The plugging of one nostril only does not seriously affect this power.

6. The dogfish obtains its food almost, if not entirely, through the use of the sense of smell.

7. The selachians possess a true sense of smell, comparable to that of the terrestrial vertebrates.

The complete paper will appear in the *Journal of Experimental Zoology*.

Habits and Reactions of the Ciliate, Lacrymaria: S. O. Mast, Goucher College.

Lacrymaria is usually found with the body well concealed in débris while the head stretches out in all directions and moves rapidly about forward and backward and from side to side apparently exploring every nook and crevice within its reach which often extends to a distance equal to eight times the length of the body. In this way the creature captures other organisms on which it feeds. It never swallows dead particles, showing that it exercises the power of selection in the process of feeding.

It is usually assumed that the movements are regulated by the contraction of tissue in the neck and body, but this is not true. The head is not thrust out, it is pulled out. Nearly all of its actions are due to the activity of a band of powerful cilia which extends around the mouth. Thus *Lacrymaria* is much like an organism composed of two independent parts united by means of an extremely elastic substance far more elastic than any known lifeless material. When the neck is fully extended it is frequently fifty times as long as when contracted.

There is no indication of orientation in *Lacrymaria* under any condition. It does not respond to light. None of its reactions fulfil the demands of any of Loeb's definitions of tropisms. The movement of the entire organism is almost entirely regulated by the reactions of the head, and the direction of movement of the head is regulated almost entirely by internal factors, it is practically independent of the location of the stimulus. We assume that all of the reactions in this animal are definitely determined by physico-chemical processes, but whether they are or not has by no means been demonstrated.

The complete paper will probably be published in the *Journal of Animal Behavior*.

The Reaction System of the Flagellate, Peranema: S. O. Mast, Goucher College.

Under natural conditions *Peranema* rarely swims. It ordinarily moves in contact with the substratum without rotating. Only the tip of the flagellum is active. This is bent at right angles to the rest and strikes strongly backward. When the organism is stimulated no matter by what means or at what point it responds by turning the anterior end with the flagellum sharply, always toward the same side. Then it straightens out and proceeds on a new course usually at an angle of about 90° with the old. If the stimulus does not cease the same reaction is repeated until it does. This is the only method which *Peranema* has for changing its course in its usual method of locomotion. The action of the flagellum is not functional in this. If strongly and repeatedly stimulated a larger portion of the flagellum may be brought into action and there may be peristaltic contractions in the body. Both of these processes affect the rate of motion but not the direction. The direction of turning is entirely dependent upon internal factors, it is independent of the location of the stimulus on the body. The direction of movement is not definitely determined by external factors. It is dependent upon "trial" positions which are assumed by turning the anterior end in response to a stimulus, only such as do away with the action of the stimulus are followed up.

The complete paper will probably be published in the *Journal of Animal Behavior*.

The Behavior of Certain Arthropods in Relation to Color Environment: A. S. Pearse, University of Michigan.

As a result of experiments with crayfishes, caddis-fly larvæ, spider crabs and spiders the conclusion is drawn that protectively colored arthropods do not select an environment similar to their own, at least they do not make such selection on account of color.

The complete paper will be published in the *Journal of Animal Behavior*, Vol. I., pp. 79–110.

On the Regenerative Power of the Dissociated Cells in Hydroids: H. V. Wilson, University of North Carolina.

It had been shown that when certain sponges are broken up into their constituent cells, the cells will reunite and form masses capable of differentiation into functional sponges. Two hydroids, *Pennaria* and *Eudendrium*, were found to possess the same power. The dissociated cells

and small cell aggregates fuse and give rise to lumps, which become smooth and secrete a perisarc. Their size and shape are within control. Such bodies are solid masses in which cell limits exist, although the structure may be in part syncytial. They show at first but little change and are subject to great mortality. After two or three days many throw out one or more cylindrical outgrowths in which ectoderm and entoderm are differentiated. In the case of some of these, growth and differentiation continue until the end of the outgrowth is transformed into a perfect hydranth.

Masses resembling those just described were obtained in a similar way from an alcyonarian, *Leptogorgia*, and when the immature gonad of *Asterias* was broken up, the cells quickly fused, forming lumps and plates. Probably the power to fuse resident in the cells and cell aggregates into which a body (in the case of lower metazoan) or tissue (in case of higher form) may be broken up is wide spread. What degrees of regenerative power may be resident in such masses is a matter for investigation. (Paper to appear in the *Journal of Experimental Zoology*.)

The Problem of Form in Hydra: HERBERT W. RAND, Harvard University.

In the problem of form as presented in ontogenesis we have progressed so far as to be able to state confidently that the essential form determining factors are within the organism itself. We must now discover to what extent and where in the organism these formative agencies are localized. The line of attack upon this problem lies in experiments involving various derangements of the normal form of relatively simple organisms. The available morphogenetic data upon *Hydra* probably exceed in quantity and diversity those upon any other equally simple organism.

An examination of the total evidence afforded by *Hydra* leads to the conclusion that in the normal adult the peristome is the seat of some peculiarity by virtue of which that region exercises formative control over column substance, whether it be substance of the column to which the peristome originally belonged, or of any other column with which the peristome material comes into relation by transplantation. When a piece of column regenerates a head, this form controlling condition is established in the prospective peristome material in advance of the visible formation of oral organs and as a prerequisite of it (Browne, 1909). *This localizing of the formative agencies is a function of the whole of the regenerating piece.* In the normal hydra, therefore, heads are not, in any direct sense, preformed at various levels of the column.

In graft compounds having two or more heads, the regulatory changes may, without exception, be interpreted as dependent upon competition of the several peristomes for control of the column substance.

The phenomena of regeneration and regulation fairly compel the assumption of the existence of a specific formative force system for which those particular chemical complexes which constitute hydra substance serve as the vehicle, and, together with the phenomena of polarity, they afford ground for some conception of the distribution and mode of operation of such a force system. (A full treatment of the subject is being prepared for publication.)

The Proportion of Male-producers in Hydatina senta as Affected by External and Internal Factors: A. FRANKLIN SHULL, Columbia University.

The proportion of male producers in the rotifer *Hydatina senta* can be reduced by rearing the animals in weak solutions of urea, several ammonium compounds, beef extract or creatin. Since some of these substances exist in the food cultures used in the experiments, starvation may appear to increase the proportion of male producers because smaller quantities of these substances are administered with the food.

Different pure lines of rotifers obtained from widely separated localities yielded different proportions of male producers when reared under the same conditions; this indicates the existence of an internal factor that plays a rôle in determining the proportion of male producers. When individuals belonging to distinct pure lines were crossed, the offspring gave rise to pure lines (F_1) yielding more male-producers than either parent line. When a member of one of these F_1 lines was crossed with an individual from one of the parent lines, the zygote gave rise to a line (F_2) producing a proportion of male producers intermediate between those of its two parent lines. The explanation of these results is not yet clear. (To be published in the *Journal of Experimental Zoology*.)

Evolution of Hectocotylism among Cephalopods: G. A. DREW, University of Maine.

The paper read will be included in a paper bearing the following title: "Sexual Activities of the Squid, *Loligo pealii* (Les.)—1. Copulation, Egg laying and Fertilization." It is to be pub-

lished in the *Journal of Morphology* during the year of 1911

The Idiochromosomes in Ascaris felis C. L. Edwards, 661 East 170th St., New York City

Effect of Conjugation on the Stock in Paramecium: H. S. Jennings, Johns Hopkins University

The Organs of Equilibration in Pelecypod Mollusca Ulric Dahlgren, Princeton University

The Anatomical Basis of Mulatto Color H. E. Jordan, University of Virginia

This paper will appear in the *American Naturalist*

Variation in the Embryos of the Hagfish, Homea (Bdellostoma) stouti Bashford Dean, Columbia University

A New Phase of the Question of the Irritability of the Skin of Vertebrates to Chemical Stimuli G. E. Coghill, Denison University

The Comparative Toxicity of a Series of Electrolytic and Non-electrolytic Compounds with Respect to Fundulus heteroclitus R. E. Sheldon, University of Pittsburgh (Introduced by S. H. Gage)

The Senses, Courtship and Mating in Tarantulas A. Petrunkevitch, Yale University

A Case of Regeneration in Tarantulas A. Petrunkevitch, Yale University

The Origin and Heredity of Four Wing Mutations in Drosophila. T. H. Morgan, Columbia University

The Heredity of Red Eyes, White Eyes and Pink Eyes in Drosophila: T. H. Morgan, Columbia University

The University of Michigan Biological Station A. S. Pearse, University of Michigan

In addition to the papers read the following exhibits and demonstrations were presented

Specimens of the 2100th Generation of Paramecium aurelia, attained without Conjugation or Artificial Stimulation L. L. Woodruff, Yale University (Presented by title only)

On the Senses, Courtship and Mating in Tarantulas—Regeneration in Tarantulas A. Petrunkevitch, Yale University

Inheritance of Color in Colias philodice: J. H. Gerould, Dartmouth College.

Regeneration in Hydroids H. V. Wilson, University of North Carolina

Raymond Pearl,
Secretary

THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

SECTION D—MINNEAPOLIS MEETING

The section held its meetings on Thursday and Friday of convocation week The Thursday morning session was devoted to the routine business connected with election of officers and fellows and to a program of papers, ten in number, of which eight were devoted to road and highway problems These papers were interesting and valuable contributions and should have been heard by a much larger audience than were in attendance

Thursday afternoon the section met in joint session with Section B and listened to the address of retiring Vice president Hayford of Section D on the subject "The Relation of Isostasy to Geodesy, Geology and Geophysics" and to that of Vice president L. A. Bauer, entitled, "The Broader Aspects of Research in Terrestrial Magnetism" Both addresses have been published in full in Science and are well worth reading by those who heard them at the meeting as well as by others interested in the subjects These sections have ever been fortunate in their vice presidential addresses

Thursday evening was given over to a dinner and smoker for the members of Sections A, B and D and the Chicago Section of the American Mathematical Society The dinner was served by the Commercial Club of Minneapolis The post-prandial remarks were enjoyed and enjoyable

Friday morning Section D held a session devoted to Aeronautics at which nine papers were read by or for the authors Quite appropriately the program opened with an appreciation of Dr Octave Chanute written by James Means, of Boston, and presented by Professor A. Lawrence Rotch, vice-president of the section This contribution will be printed in full in Science On Friday afternoon, Sections A, D and the Chicago Section of the American Mathematical Society met in joint session for a symposium on engineering mathematics, the same being a discussion of a preliminary report on the subject prepared by a committee appointed at the time of the Chicago meeting of the American Association for the Advancement of Science Printed copies of the report had been prepared by the chairman of the committee, Professor E. V. Huntington, of Howard University, who opened the discussion, which was continued with spirit during the entire session with profit to all present.

Professor A. Lawrence Rotch, vice-president of

the association and chairman of Section D, presided at all meetings of the section and at the joint session of Sections B and D

The officers for the Washington meeting of the section are as follows

Vice president—C S Howe, Case School of Applied Science

Retiring Vice president—A Lawrence Rotch, Blue Hill Observatory

Secretary—G W Bissell, Michigan Agricultural College

Member of the Council—A F Zahm, Washington, D C

Member of General Committee—O F Marvin, University of Kansas

Sectional Committee—T E Boyd, Ohio State University, A H Blanchard, Brown University, C M Woodward, Washington University, W J Humphreys, Mount Weather Observatory, G O Squier, U S A

Herewith are titles and abstracts of the papers presented

The Amount of Stream flow in the Northern Prairies E F CHANDLER, University of North Dakota.

In the prairie regions of the northern United States, there have been until lately no stream-flow records available Within the past decade, the U S Geological Survey and other agencies have maintained fairly extensive records here It is now known that in this region the stream-flow or "run off" is far less than formerly supposed In North Dakota, as a particular example, it is seen that some former estimates were as much as 500 per cent in error, for the average annual run off is less than one inch and the total of a single year is frequently less than one half inch

The run off from any drainage area depends upon its topography, geological structure, etc, and upon its total rain fall and the seasonal distribution and intensity of the rains But where the run off is as small as here considered, it is very improper and misleading to follow the frequent custom of speaking of the run off as a *percentage* of the rainfall

The only basis upon which any reasonable estimates can be made is a comprehensive set of rainfall and stream flow records extending through a long period of years Rain fall records alone are not sufficient, this statement applies especially to regions where the stream flow is only a small percentage of the rainfall

Consequence of Solution of Air in the Hydraulic Air Compressor F W MCNAIR and GEO A KOENIG, Houghton, Mich

Brief description of the Taylor compressor at the Victoria Mine, difficulty with lights in the mine, plan of the mine, conditions due to "compressor air" as affecting lights and men, comment on efficiency of compressor, desirability of further investigation, being a brief résumé of the results of an investigation made in the spring of 1907 by the authors

A Comparison of English and American Traffic Regulations A H BLANCHARD, Brown University, and H B DROWNE, Providence, R I

From the standpoint of the highway engineer the following regulations should be made a part of the laws relative to the use of highways by various kinds of traffic The proposed regulations are based on conclusions arrived at after a careful consideration of the effect of various classes of traffic on road surfaces as exemplified by American and European practice

1 All horse drawn vehicles shall be equipped with a light or lights

2 All vehicles, either horse drawn or motor driven, having iron tires and using the improved state roads shall be provided with tires of widths such that for a 2 foot wheel 500 pounds shall be the maximum pressure per linear inch of width per wheel, but an additional pressure of 30 pounds per inch shall be allowed for each additional 3 inches in diameter The maximum width of tires for horse drawn vehicles shall be 6 inches All iron tires must be smooth The width out to out of all classes of vehicles, including the superimposed load, shall not exceed 8 feet

3 The maximum speed of motor cars on all highways shall not be greater than is reasonable and proper, having regard to all classes of traffic and local environment

4 Vehicles shall be so constructed that the driver or operator shall sit on the left rather than on the right

5 Motor cars (including traction engines) hauling trailers shall keep to the right side of the center of the road No more than three trailers shall be allowed in any train Pneumatic tires or tires made of soft or elastic material shall not be equipped with chains, metal studs or some other non skidding device of this character except in the case of passenger vehicles carrying not more than seven persons

6 The intensity of powerful acetylene lights on motor vehicles, including those running on rails, shall be diminished on the approach of other vehicles

7 Sign posts shall be erected by the state highway departments to give notice of points of danger and to give information as to the route of the road

Relation between Modern Traffic and the Alignment and Profile in Highway Design H B DROWNE, Providence, R I

Preliminary to designing a road, a careful study should be made of the existing traffic conditions and those to be expected, since there are several features in the design that depend upon whether a road is to serve only a horse drawn vehicle traffic, a combination horse-drawn vehicle and motor car traffic or a motor car traffic alone Wider roads are required where there is much motor car traffic and on important roads a minimum width of twenty feet is advocated Also the transverse slope or crown of the road should be made from one fourth inch to one half inch per foot Sharp curves are not detrimental to a road that takes mostly a horse drawn vehicle traffic, but if a heavy motor car traffic is expected all bad curves should be eliminated or reduced as much as possible, since they are not only expensive to maintain but are also extremely dangerous Moreover, the curves should have a one way slope up from the inside edge, as this will distribute the wear more evenly over the entire width of the road There is no need of reducing the maximum grades now in common use on the improved roads

The Present Status of the Use of Bituminous Materials in the Construction and Maintenance of Roads in the United States A H BLANCHARD, Brown University

As an indication of the development of the use of bituminous materials in road construction and maintenance, statistics are submitted based on the work accomplished by the state highway departments of Maine, Maryland, Massachusetts, New Hampshire, New Jersey, New York and Rhode Island The total amounts of bituminous work in the various years are as follows 1908, 350,000 sq yds; 1909, 7,750,000 sq yds; 1910, 18,000,000 sq yds.

The most notable developments have been (1) In the increased use of liquid asphalt and heavy asphaltic oils for surface treatment as is shown by the following figures, 1908, 208,000 sq yds, 1910, 2,434,000 sq yds (2) In the increased use of light oil as a dust layer, as is indicated by its non employment in 1908, while 9,825,000 sq yds were treated in 1910 (3) The extensive use of asphalts, solid at ordinary temperatures, or combinations of asphalt and tar in connection with the penetration method of constructing bituminous pavements, the total square yards built in 1910 being 4,400,000 sq yds, while no work of this character was done in 1908 (4) The increase in the use of liquid asphalts and heavy asphaltic oils in the construction of bituminous pavements by the mixing method, as is shown by the following figures, 1908, 3,000 sq yds, 1909, 151,000 sq yds, and in 1910, 335,000 sq yds

Also attention is called to the more general use of refined tar in place of crude tar, the increased use of mechanical distributors both in the surface treatment of old roads and the construction of bituminous pavements by the penetration method and the introduction of mixing machines in connection with the construction of bituminous pavements by the mixing method on state highway work

Certain Considerations affecting the Selection of Bituminous and Mineral Matter for Road Construction and Surface Treatment J O TRAVILLA, St Louis, Mo

Highway engineers are giving much attention to the investigation of bitumens and to the development of specifications for bituminous materials, but in the opinion of the writer insufficient attention is paid to the study of the mineral aggregate The life of an asphalt or bitulithic pavement has been shown to depend upon the character of the aggregate to a great extent, and in the case of bituminous concrete or a bituminous wearing surface the same is true

In general mineral dust is as objectionable as moisture in the construction of bituminous roads

The wearing qualities of the mineral matter employed affect the life of a road and also the form of construction In the case of a very soft stone better results ensue when the larger stone is placed on top.

The writer's experience proves to him that resiliency in the surface is of importance in lengthening the life of a road or pavement Bitumens should, therefore, not be brittle at low temperatures nor should they be too soft at high temperatures St Louis has specifications governing the special adaptability and the methods of application for surface treatment of four grades of oil

Care should be taken to keep oiled streets clean The oiling of all road intersections is important in this connection.

Need of and the Opportunity for Technically-trained Men in Highway Work A N JOHNSON, Springfield, Ill.

This paper reviews briefly the history of road

building in the United States, noting that from the time of the advent of railroad construction, little or no attention was given by engineers to road work until about 1890, when some of the eastern states took up the question of road improvement from state-wide view points, since which time large sums of money have been appropriated by different states for the systematic study and construction of roads, that this work is now demanding the service of trained men and the people generally are realizing the necessity of such service

In presenting the paper, the writer illustrated with lantern slides some of the conditions found in highway work in Illinois and the methods of the road and bridge construction undertaken by the Illinois Highway Commission which would be representative of the conditions and methods applicable to a wide area of the Mississippi Valley region

Methods of Taking Traffic Census on Highways A H BLANCHARD and I W PATTERSON, Providence, R I

The value of statistics relative to traffic on highways, taken previous to their construction, is generally admitted, but the methods to be employed in the securing of such statistics have not been discussed in the technical press except relative to the classification of traffic

In view of the fact of their close relation to the wear of a road surface, the following elements of classification should be noted differentiation between horse drawn and motor car traffic, distinction between pleasure and commercial traffic, subdivision of commercial traffic into loaded and unloaded vehicles, weight per linear inch of tire of commercial traffic, number of horses drawing vehicle, weight and speed of motor cars and abnormal local traffic of extraordinary character Numerous highway supervisory bodies have drawn up forms which include the above important items more or less completely

The methods of securing traffic data are of extreme importance The methods where two extremes of time (one year and one month) are available for traffic census are discussed The following three methods applicable in both cases are considered (1) observations upon single days at regular intervals, (2) observations through a period of several consecutive days at intervals, (3) observations covering a period of three days, including Saturday and Sunday, at intervals The last-named method appears from the standpoint of economy of labor, probable clemency of weather (weather conditions at Providence, R I, considered in each case for a period of five years), and results obtained to be the most practical method for general use

The Present Status of the Relationship between Laboratory Tests and the Use of Road Materials W W CROSBY, Baltimore, Md

The science underlying the art of roadmaking is obtaining recognition For its development, laboratory tests and records of experience are necessary Some such have been available in the past, but these are, from their incompleteness, unsatisfactory now, especially as regards new materials and altered conditions of traffic By reference to the records and use of such tests as those for the resistance to abrasion of stone and the cementing qualities of the stone powder, is shown the value of such tests, and, at the same time, the incompleteness of the present knowledge More complete information is stated to be desirable as well as information along other lines, such for instance as the strength of stone under compression

The changes in traffic conditions, and the new records of the experience with both old and new materials under the changed conditions are referred to with some suggestions as to what definite information may be desirable

The statement is made that records from experience are needed, and not conclusions from assumed theories alone Also that the author believes it may be possible eventually to reduce many of the problems of highway engineering to a mathematical solution The beginning of the work of collecting information, and the desirability of cooperation are mentioned

Dr Octave Chanute and his Work in Engineering and Aeronautics JAMES MEANS, Boston, Mass

An appreciative review of the achievements of Dr Chanute (Published in full in SCIENCE)

Permanent Winds, their Causes and Directions. W J HUMPHREYS, Washington, D C

The temperature difference between tropical regions and those of higher latitudes establishes a barometric gradient from the warmer to the colder parts of the earth The resulting flow of the air together with the rotation of the earth causes the air of higher latitudes to flow from west to east, and that of the equatorial regions from east to west. The opposing centrifugal forces thus set up are the cause of belts of high pressure at latitudes 30° to 35° both north and south

These belts of high pressure are underrun at five places, two in the Pacific Ocean, two in the

Atlantic and one in the Indian, by cold ocean currents. Hence, each of these five places is the seat of a permanent high or anticyclone with its attendant permanent circular winds.

An Indicator for Determining the Efficiency of Aeroplanes or Kites: S. P. FERGUSON, Reno, Nev.

The author has devised a compact self recording instrument for indicating continuously the angle of incidence and lateral inclination of an aeroplane or kite together with the velocity, and the lateral and vertical oscillations in the direction of the wind with reference to the flying machine upon which it is carried. This instrument is based upon the kite meteorograph designed in 1905 by the author.

Determination of Altitudes of Aeroplanes by Triangulation: R. W. WILSON, Cambridge, Mass.

This paper contains an account of observations made by two methods to determine the maximum height reached by aeroplanes and a comparison of the results obtained at the Harvard Aviation Meet.

By one method observations were made with sextants in a fixed vertical plane which the aviator was to cross at his greatest altitude. Simultaneously observations were made by the other method in which theodolites were placed at the extremities of a base line three miles south of the field.

Technical Education in Aeronautics: C. H. PEABODY, Boston, Mass.

Technical education must eventually be offered for aeronautical engineers, the question is whether now is the time. The phases of this question are financial support, subject matter for instruction, method of securing teachers. The writer favors training a teacher for the purpose, and the establishment of undergraduate courses of instruction now. He offers a suggested course parallel to a course for naval architects.

A Program of Aeronautical Research Work, with Special Reference to what may be done at the Colleges: A. A. MERRILL, Boston, Mass.

In this paper the work suggests four general lines along which research could be profitably conducted: (1) the problem of construction, (2) the problem of efficiency, (3) the problem of power, (4) the problem of stability.

In connection with each problem the author pointed out just what research work is necessary and to what extent the colleges are fitted to undertake this work.

Some Experiments on the Pressure of a Current of Air on Certain Surfaces: G. LANZA, Boston, Mass.

The paper explains the need of an apparatus consisting of a blower, for the production of a current of air, and of a tube for directing this current against the surface to be experimented upon. Also the means of obtaining a current free from gusts, and having a uniform velocity at all points of the cross section of the tube.

Reasons are also given why the experimental surface should not be placed inside the tube, but should be located outside of and near its mouth.

The value of K in the formula $P = KV^2$ was found as a result of these experiments to be $K = 0.0031$, whence $P =$ pressure in pounds, and $V =$ velocity in miles per hour, the experimental surface being a plane surface one foot square placed at right angles to the current.

The results are also given which were obtained by an investigation of the vortex formed under the prow of a surface formed to approximate the underside of the wings of certain birds, and placed at small angles of inclination to the current. The need of a larger apparatus of the same kind is urged.

The Increase of Wind-pressure on a Normal Surface with Height: A. H. PALMER, Hyde Park, Mass.

The increase of wind pressure on a normal surface with increasing height is of considerable importance in aeronautical construction. From the known decrease of atmospheric pressure with height, and the wind velocity in the free air obtained by means of kites and observations of clouds at Blue Hill Observatory, the wind-pressure in pounds per square foot upon a vertical plane has been computed and has been plotted in a diagram.

Normal Stress and Resultant Pressure: A. F. ZAHM, Washington, D. C.

Extract from forthcoming book on "Aerodynamics" by Mr. Zahm.

Early Attempts to Navigate the Air: J. J. GREEN, Notre Dame, Ind.

Outline of history of aerial navigation from the time of Daedalus and Icarus through the middle ages down to the invention of the balloon. Scientific work done with the balloon. Its use by the postal authorities during the siege of Paris. Langley, Lilienthal, Chanute, Ader and their work, brief statements except in case of Ader's work.

G. W. BISSELL,
Secretary

EAST LANSING, MICH.

SCIENCE

FRIDAY, MARCH 17, 1911

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MSS. intended for publication and books, etc., intended for review should be sent to the Editor of SCIENCE, Garrison-on-Hudson, N. Y.

THE BASIS AND OBJECT OF ARCHEOLOGICAL RESEARCH IN MEXICO AND ADJOINING COUNTRIES[1]

BY the mutual agreement between the government of Mexico and other governments and scientific societies of Europe and America, it has been decided to establish an International School of American Archeology and Ethnology in the City of Mexico, and as the honor of being the first director of the school has fallen to my share, I beg leave to place before this illustrious assembly the reasons which determined the patrons and protectors of the school to found it, and to dwell a little more fully on the ends that we hope to achieve in this new institution

We call our school the "International School of American Archeology and Ethnology," that is to say, we wish to treat two sciences, the importance of which is more and more clearly recognized in our day, and which are in reality sisters—for what we call archeology is but a branch of ethnology, from which it differs rather in method than in aim Archeology has reached its highest development and

[1] Inaugural address of the director at the opening of the International School of American Archeology and Ethnology in Mexico City on January 20 Porfirio Diaz, president of the Mexican republic, opened the school in the presence of the ministers of state and public instruction of the republic, of the ambassadors of countries that participate in the establishment of the school, and of many prominent citizens After the inaugural address by Professor Seler and an address by Señor Ezequiel A Chávez, subsecretary of public instruction, who dwelt on the importance of international cooperation in the establishment of the school, the president declared the school opened.

achieved its greatest triumphs in classical archeology and in the prehistoric archeology of Europe. For centuries the political and civil history of the Romans, Greeks and Oriental nations have been taught in the schools of the Old World. By the efforts of thousands of learned and industrious investigators, whatever knowledge could be obtained from descriptions and reports of historians, from the study of monuments that have survived the destruction of the old world, has been recorded and secured for the benefit of scientists and of the general public. We may say without exaggeration that an exact knowledge of the political and social life and of the characteristics of the individual life of the people of antiquity, a true concept of the extent of the influences arising therefrom, of the influences these civilizations received from the neighboring countries, and of the source from which they sprang,—was not attained until ancient history applied archeological methods, until by the use of the spade were unearthed the homes, graves, utensils, arms, ornaments, costumes, the remains of human bodies, and the worm-eaten literature of that ancient people.

Thus it was proved that field work was most necessary for the progress of archeology, underground lie the documents, truthful witnesses of the ancient civilizations about which we read, underground lie also the remains that are witnesses of civilizations, and the forms of primitive development of which no historian has written a single word. It is only necessary to bring them to light. However, for this kind of work, the energies of a single man are insufficient, no matter how skillful, diligent or learned he may be. Nor are the means sufficient which a scientist standing alone has at his disposal.

For these reasons in different countries of the European continent, the governments have taken upon themselves to establish and support institutions, to appoint directors and assistants who are charged with the task of exploring the centers of ancient civilizations, in the classic soil of Italy, Greece, Egypt, Babylonia, Assyria and other parts of the world. Associations of private citizens interested in this subject compete with the governments. In this way were organized the French, German, English and Austrian schools and those of the United States of America and other nations, in Rome, Athens, Smyrna, Cairo, Crete, Babylon, etc.

In establishing the institutions, the governments, scientists and scientific societies had a double purpose. The first and foremost was of course to learn as accurately and as completely as possible the characteristics of that great civilization whose heirs are we who live in Europe now, and which has spread to this continent and to other parts of the world. To accomplish this purpose it was important to preserve the relics that were found, to collect small objects and to note the places where they were discovered and the manner in which they had been deposited, and to keep them in museums.

The other object which the governments and scientific associations wished to attain was more particularly of an educational character. This purpose was partly accomplished by the museums, which were enriched by the finds made by archeological research. The peculiar traits as well as the artistic character of the remains that had been collected were admirably adapted to impress the imagination and to teach the young. There are, however, a great many things which can not be kept in museums, and there are many others which can only be seen and studied in the museums of the countries in which they have been found.

There are—most important of all—the people, the descendants of the ancient civilized nations, their countries, their skies, their climate, their whole environment, their way of living and the whole combination of imponderable agencies, the knowledge of which enables the student to understand the thousand peculiarities of the life and fate of the people. All of these and the particular methods of investigation were what was desired to teach the young in the schools of archeology that have been established with so much liberality in the classic countries of the Old World.

Work of this kind has been in operation for generations and with marked success. Whole cities arose anew from the accumulation of débris of thousands of years that had covered them, temples with rich ornamentation were restored, the secrets of the Egyptian pyramids, of the temples of Babylonia and Assyria, were brought to our view, together with countless objects, many of which were of inestimable value. These were preserved to delight the eye and satisfy the mind of mankind, and from them many students have learned to see, understand and work.

On the American continent, in the United States and in the Dominion of Canada, great interest was manifested in the ethnology of the Indian races and in its antiquities ever since the middle of the past century. Scientific associations and private parties rivalled in collecting data and documents, and the governments, aided by liberal means, undertook the direction of the investigation. Recently archeological investigations have also been instituted on a larger scale in South America in the Argentine Republic, particularly in the Andean region of that republic. Something has also been done in Brazil, Bolivia, Peru and Ecuador, by the cooperation of private parties, institutions of the United States and the governments of South America. Some foreigners have also worked in the republics of Central America, as well as in Yucatan and Chiapas: the Englishman Alfred P. Maudslay, the Frenchman Désiré Charney, the investigators of the Peabody Museum of Cambridge, Mass., the Germans Berendt and Teoberto Maler, the Swedes Bovallius and Hartman. Great additions to our knowledge of the ancient peoples of those regions were derived from their work. In Mexico the explorations authorized by the government in Xochicalco, Cempoallan, Monte Alban and Teotihuacan have contributed much to enlarge and deepen our knowledge. Magnificent monuments which were little known, and which were covered by débris or hidden by tropical vegetation, were unveiled. This work awakened more and more interest among the educated classes of other countries, and especially among our neighbors to the north. Thus arose the idea of cooperation, of the union of efforts, of the necessity of establishing a center to direct the work, at which the young student can learn, who, full of enthusiasm for those studies, might wish to come here to learn what books and the objects accumulated in museums could not teach him. This was the object and aim in founding a school of the same kind as existed in Rome, and with the same aims, but international in character. It is not necessary to enter into details to show the particular opportunities of such a school in this country, but we shall be grateful to those who initiated and fathered the idea, for the zeal and perseverance with which they worked to accomplish their end. We must be grateful particularly to the government of this republic, that owns this soil, and to the ministry of public instruction, whose solicitude for the study and preservation of all the archeological treasures of this country is

well known, and which with great kindness supported the project and lent it its efficient aid

Permit me now to set forth in a few words the tasks that this new institution will have to take up, and the way in which I think the work should proceed

The historian places the highest value on the testimony he can gather from living witnesses The descendants of the ancient peoples of this country, in so far as they still speak their old languages and observe their old customs, are in a way living witnesses, whose testimony is of value for the knowledge of ancient history, ancient political and social life The Indian of this country holds so tenaciously to his old customs, he is so devoted to the soil of his birth and that of his ancestors, that only by main force can he be taken from it

When we remember that since the time of the Conquest all hostilities and wars between the tribes have ceased, we may take it for granted that on the whole, and with few exceptions, the geographical distribution of tribes that exists to-day is the same as at the time of the Conquest, that is to say, that if a certain native language is now spoken in a certain place, we may assume until the contrary is proven that the same language was spoken there at the time of the Conquest For this reason it is of the greatest importance, not only for the ethnologist, but also for the historian and archeologist, to have an exact knowledge of the geographical distribution of the Indian languages spoken to-day, and for this reason I consider the preparation of a map that will give all the details of this distribution, as one of the labors that should occupy the attention of the International School of Archæology and Ethnology established to-day

The people who speak the same language do not necessarily form a homogeneous group, there are differences among them which correspond to the diversity of place and condition in which they live or lived, and to their history Such differences express themselves even in language, and for this reason the study of the dialects is also essential for historical investigation, and will form one of the tasks of the International School We are grateful to my distinguished colleague, Dr Boas, who offers his thorough knowledge and experience in this laborious enterprise

Another help in our investigation that may be of great value are the Indian people of to-day, in so far as they still retain the customs of their forefathers of the time of the Conquest, and in so far as they still retain the traditions, beliefs and tales, adulterated or not, which belonged to the time of paganism The folk-lore of the Indian tribes of this country will be another and very important part of the labors of our school

Lastly, we should not forget to study the industries and art of the Indian people, however much they may have been influenced, mixed and changed by the artistic style and the industries that the Spaniards brought with them, there remain in many places the survivals of ancient industry, designs and forms that remind us of ancient styles, that will be of value for purposes of comparison, and that may complete the history of ancient design and help us in its interpretation.

Archeology proper—that is to say, the ethnology of the races and peoples that no longer exist—has the same aims as ethnology, but its methods are much more limited. The archeologist can not collect at will from living people the elements of the language that was spoken, the traditions, the tales, the beliefs and all the evidence of mental development He must be satisfied with what writers of earlier times—

investigators, historians or general writers—considered worth while to note down. Nor can the archeologist investigate the entire cultural work of a race or people He can only depend upon the little that good fortune has saved from general destruction, caused by the violence of man, by his negligence and the destructive agencies of time, climate and vegetation The more is it important for the scientists to collect all the evidence, important as well as that of seeming insignificance, to keep account of the notes that refer to the evidence, to its origin, etc, and to utilize thoroughly the written documents, the descriptions of historians and of the contemporaries of those times, in order to obtain from these documents all possible help for the interpretation of the history of the people

Useful documents are not lacking in this country—that is, in the region with which historians have particularly occupied themselves—in this valley, in the environment of the capital and among the Tlatepotzcas (people that live beyond the mountains), in Cholula, Tlaxcala and its dependencies, the home of the nation or nations that were leaders in this country Beyond the limits of the central region, in the provinces, the reports and documents are very scarce There is no Sahagun for Michoacan and the northeast, nor for the Otomis, near neighbors of the Mexicans of the central region, nor for the gulf coast, nor for the great and rich provinces of the Zapotecas and Mixtecas; and the same is true of the region of the isthmus and the different parts of the people of the Maya family Regarding all these large provinces we have not more than scattered notes, and few incoherent accounts. Here archeology is the only means that can furnish the data, or any data necessary for the reconstruction of the history of these ancient people and the characteristics of their civilizations

The International School, in its archeological department, will, in the first place, study the monuments that are in existence and that are accessible, making comparisons and trying to interpret them by means of the old trustworthy accounts, and by means of what may be gleaned from the paintings, the contemporaries of pagan times, or of those made not long after the Conquest

The Maya monuments are a problem in themselves As this people had developed the art of writing to a higher degree than any other people on this continent, having originated very nearly a true hieroglyphic writing, and as at the same time they used these characters and signs frequently in their books as well as in their architecture, the Maya monuments should teach us more than those that are found in other parts Unfortunately, in that region an authoritative interpretation is lacking entirely Some of the characters have been deciphered, much more remains to be deciphered The International School will also apply its efforts to this important but difficult branch of the investigation.

The principal work with which the International School will occupy itself will be the search for new material, choosing appropriate places for which the authorities in whose charge the preservation of the monuments of the country is placed, will give the needed authority; discovering, measuring and studying what is found, looking for and bringing together detached pieces, taking photographs and drawings of entire monuments, of special details, opening burials and securing the contents for the museum of the nation.

The school will make efforts to fill in the fragmentary picture of our knowledge in order to give us a better idea of the differ-

ent civilizations that existed in this country—an idea that unfortunately the writers of earlier times did not give us

At the same time, we must not forget to study the cultural strata to see if there be in some place some means of arriving at a classification or chronological order in which the civilizations followed one another, a history that we have not been able to establish up to this day All these propositions will require the cooperation of the young who will learn and will in turn become our teachers, who will continue our work, disregarding and boldly setting aside the doubts and hesitancies of the old, and who will not fear to open new paths and with youthful vigor bring to a happy end what we have only been able to begin

EDUARD SELER

THE PLACE OF RESEARCH IN UNDERGRADUATE SCHOOLS[1]

THE aim of this academy is the encouragement of research along scientific lines by establishing and maintaining intercourse among those engaged therein, thus stimulating them by a consciousness of companionship in productive intellectual activity In a small society, embracing in its scope all the sciences, one does not expect in these days of specialization to find others engaged in just the same field of investigation as himself, it is through inspiration rather than information that the investigator profits by these meetings

It is now hardly necessary to emphasize, even to the non-scientific public, the importance of scientific research, to it mankind owes in a large measure not only his material prosperity, comforts and conveniences, which is sufficiently obvious, but, what is even more important, his intellectual freedom. The changes that have taken place within the last century in our physical environment, with the innumerable applications of science to useful purposes, are no more profound than our intellectual advance and the growing pervasiveness of the scientific spirit in all lines of thought and endeavor for human betterment, physical, social and moral. Our increasingly extensive and effective philanthropies, our giant strides in sanitary administration, and the tottering barriers between the sects of Christendom, are very tangible evidences of the spirit that is not satisfied with precedent or authority, but craves certainty as to the facts, and reasonable explanations for them, as well as the application of all knowledge to the uses of man

The membership of this academy happily includes scientific workers in many fields Some apply the results of research to the needs of the state in developing its resources and protecting its citizens against the injuries inflicted by ignorance and fraud, others make science the servant of industry and commerce, others, again, are active in applying it to the preserving and restoring of the health of our bodies A large part of our membership, however, is made up of those whose chief occupation is teaching

While it has not always been the case, it is probably true at present that the most valuable contributions to human knowledge are made by those engaged in this profession of teaching This is not surprising, for the nature of his calling demands that the teacher to be effective must ever continue to be a student, and the thorough study of any subject reveals the limits of our knowledge in that field and tempts the man of active intellect to the task of extending those boundaries; there is surely no keener pleasure than the learning by one's own search some truth, however inconspicuous, not previously known.

[1] Address of the president of the Indiana Academy of Science, November 25, 1910.

Not only does teaching tend to stimulate research, it also gives it balance by preventing the too exclusive attention to the comparatively narrow field under intensive cultivation, the necessity of presenting well-ordered information covering the broader subject, and the oral statement of original theories and conclusions, must have a broadening and clarifying influence on the intellectual activity of the investigator

As teaching is a help to research, still more is research a vitalizer of teaching, particularly of the teaching appropriate for graduate students, indeed, the work of research is at least as important as that of instruction where advanced students are concerned, and the university should be a source of new knowledge, where those desiring to devote themselves to the same high quest may be stimulated by the example and companionship of productive scholars

The leading European nations have apparently realized more clearly than we the value of scientific research, and have provided more adequate rewards and more favorable environment for the investigator, with the result that the ratio of intellectual to material prosperity is higher there than here Within the past generation, however, we have become more awake to these matters, and have determined in our strenuous way to make research "hum" The awakening has unquestionably been beneficial on the whole, but we have, it seems to me, failed to grasp certain fundamental distinctions between the needs of graduate and of undergraduate students, the hum of research has been allowed to drown the cries of the injured in many an undergraduate school, where teaching is sacrificed to research, and where too early specialization is encouraged and even forced upon the student.

We are not as yet in this country producing our proper share of scholars of the first rank The reasons for this are many, including hasty preparation, premature specialization, insufficient rewards, and unfavorable environment

As to preparation, those of us who contemplate academic careers are usually unwilling to invest sufficient capital of time and money, we expect to complete our scholastic education, if uninterrupted, at about twenty-five years of age and then enter upon an active career in which there is little time or opportunity for research or even very serious or intensive study, for the sake of the immediate pecuniary reward, in Europe, several more years are spent in subordinate positions as investigators, on a semi-independent basis both scholastically and financially The European makes a larger investment and reaps a larger ultimate reward, not only in money, but still more in the consideration accorded to intellectual eminence

Concerning too early specialization and its shallow results, I shall speak later, let it suffice here to say that, for example, he is a poor chemist who is only a chemist

The rewards at present offered for pure scientific work in this country are insufficient to attract the most vigorous, capable and ambitious men, not only, nor chiefly, are the financial returns here less than in Europe in spite of our higher cost of living, but the public respect for intellectual distinction is far inferior in this country, on account of our commercialism and our acceptance of wealth as our standard evidence of merit

The environment, too, is less favorable to the highest scientific work in that the numbers of those engaged therein are so few, and the national characteristic of haste rather than thoroughness pervades our activity. The value of real scientific

attainment is still but dimly recognized by the industrial world, chemists are employed like clerks, without graduate training, and work like day-laborers, but for less pay, at routine analysis, with neither the training nor the opportunity to attack the larger problems in a fundamental scientific way Such chemists are not on the same plane as the higher chemists in the German manufacturing industries, who have supervision of the works as well as the laboratories One result of this primitive lack of demand for highly trained men is the small number pursuing research in our universities, so that even our best qualified professors have a mere handful of research students, and many of these can be induced to continue their higher education only by fellowships sufficient to pay their living expenses, if such aids were discontinued the numbers of our graduate students would be even less favorably impressive than at present, though in time the larger investment of those remaining would show in the larger salaries that would have to be paid to the men more difficult to find Leading German professors attract large numbers of well-trained students, making possible their remarkable productiveness.

The keener competition in all walks of life in Europe has some advantages—only the thoroughly trained can hope for success, hence their desire for the most complete preparation. We consider ourselves fortunate in being protected against foreign competition, and in being able in consequence to make an equally good living with less effort, but are we really to be congratulated on our lower intellectual standard of living and on our dependence upon imported thought and intellectual products?

Another result of the limited scale on which scientific investigation is being conducted, and our "high standard of living," is that it is not worth while for manufacturers here to supply refined or unusual scientific material, if an American investigator needs, for instance, a special chemical, he must wait two or three months for its importation, while his European colleague could obtain the same in as many days or even hours, or, if manufactured here, two or three times the foreign price must be paid The American artisan is more highly paid than his European brother, but not so the more eminent intellectual worker. Does this mean that we are not civilized enough to appreciate any but material products?

Naturally the realization of the value of intellectual things is found first among those engaged in the work of education, and our larger and better endowed colleges have within the last half century shown their appreciation of productive scholarship and developed graduate schools to compare more favorably with the European universities, so that it is no longer necessary for our students to go abroad for the inspiration of working with men who are extending the boundaries of human knowledge Once started, the fascination of research insures its continuance as long as a favorable environment exists.

The institutions that have been able by their large means to adequately maintain graduate departments have been so amply rewarded by their enhanced prestige, that many others, without sufficient means, have attempted to do the same thing; the result has been impaired undergraduate instruction with a more or less successful imitation of graduate work.

A graduate school should recognize as its most important possession the productive scholarship of its faculty, making the institution a center of new knowledge, and all other matters should be arranged with

a view to encourage and stimulate scientific investigation. A very moderate amount of class instruction and other duties should be demanded of the members of the faculty, and students should be sufficiently mature and earnest to work without compulsion and with little direction under the guidance and inspiration of the men who are doing real original work

The case of the undergraduate school is fundamentally different I believe that the prominence given to research in many undergraduate schools is a positive injury to the student; his instructors are chosen on account of their ability or promise as investigators instead of their qualifications as teachers, and even the student himself is encouraged or forced to undertake so-called research with entirely inadequate training, both as regards breadth and depth The undergraduate years should be employed in acquiring a well-balanced knowledge of the fundamentals of the student's specialty, and an acquaintance with the elements of many allied subjects, together with a working grasp of such tools as modern languages, to make professional literature accessible at first hand, mathematics, for the mental training and grasp of the quantitative and statistical treatment of all studies, and every undergraduate student should give such attention to history, literature, and economics as to make him an intelligent citizen and man of culture.

Only when this has been in a measure accomplished—and in looking back to our own college days we realize that a mere beginning had been made when we graduated—is the student in a position to profitably undertake research with a proper appreciation of what he is doing and how to do it, so that it is really research for him and he is not merely a pair of hands under the direction of another's brain. The effectiveness of a scientific investigator is generally proportional to the thoroughness of his preparation, too many attempt to discover new truths before they have grasped those already discovered by others

In many institutions one of the requirements for graduation is called a thesis, and such a tradition is difficult to dislodge, but I think the name is unfortunately pretentious and is apt to mislead the student into thinking himself more advanced than the facts justify, it savors of the same spirit that induces the high school to ape the college in so many ways, in its pernicious fraternities and even in having a "baccalaureate" service—doubtless to celebrate the fact that the boys about to graduate are still unmarried, such unwholesome symptoms are usually most conspicuous in institutions with the least merit. The preparation of an undergraduate thesis may be a valuable item in the course if it is not so administered as to waste the student's time, narrow his mind and swell his head I believe its most valuable feature is its compelling him to go to original sources for information, namely, library work Too many students graduate without this experience and with a knowledge of books limited to the prescribed texts employed in the course. To choose a subject of real interest to the student and of suitably narrow scope, and to find out by systematic search in the scientific journals all that is known about it, and then to write an essay in which the information is carefully arranged and well presented, is a task well worth the performance.

It is entirely laudable for every institution to aim at ever higher goals, not, however, by raising the entrance requirements beyond the reach of its natural constituent, even at the dictation of some self-appointed board demanding uniformity under diverse conditions, and not by

changing the object of its training—there would not be necessarily any gain to the community at large should a school of pharmacy gradually become a theological seminary or even a medical college, a school of pharmacy is just as necessary as either of the others

It is perfectly natural for any teacher or group of teachers to aspire to more advanced grades of work, but this should not be undertaken unless the more elementary and fundamental work is adequately cared for

We are suffering from too much ambition of this kind, too many trade schools attempt to be colleges, and too many colleges attempt to be universities, at the expense of their efficiency in their original equally important field Let us imagine that every grade school gradually introduced more and more work of the high school, that every high school gradually became a college, and that every college gave more and more of its energies to graduate students! Or let us imagine that every institution giving grammar school instruction attempted also to provide training through the high school, college and university curriculum! What a ridiculous and inefficient educational system must result Roughly speaking, for every thousand grade schools we need about a hundred high schools, ten colleges and technical schools, and one graduate university

Fortunately, there is a supervision that prevents the transformation of grade schools into high schools, and separates the work of the two as soon as numbers of pupils justify the step, it is a pity that there is no authority with power to insure similar efficiency on the part of undergraduate and graduate colleges and universities

We are failing to appreciate the distinction between undergraduate and graduate work In most ways there is little more in common between these than between that of the high school and of the college, and the university is injured in the attempt to make it a small part of a large college Efforts have been made in this country to have universities unhampered by undergraduate departments, unfortunately, however, the country has declared itself not yet ready for such a logical and much-to-be-desired arrangement

The chief function of the undergraduate school is to give instruction in such a way as to insure mental development For those few who are to proceed to graduate work, the soundness, breadth and depth of the foundation will largely determine the safety and usefulness of the superstructure of specialization to be erected later The first qualification for membership in the teaching staff of an undergraduate school should be teaching ability together with a thorough knowledge of the subject to be taught

This teaching ability is largely a natural gift, and if of a high order is not common. Let us recognize it, use it, and reward it as an asset of the highest value It can not be created by the study of pedagogy any more than logical thinking by the study of logic, it is founded on the intuition of sympathy Teaching is the keenest pleasure to some, the hardest drudgery to others; the student readily distinguishes the two. I would not, however, imply that even the best teacher can work effectively with the undergraduate who struggles to escape education or who is unwilling to make any effort for it because his interests are now intellectual, such students have no proper place in an institution of higher learning, and we expend much too large a part of our energy in forcing such material through to graduation The fashionableness of going to college is by no means an unmixed blessing Why does not some en-

terprising individual start a college with luxurious dormitories and means of recreation and dissipation, where work shall be optional and house-parties continuous? Enormous fees could be charged, professional athletes employed, a suitable degree conferred after four years, and the working colleges protected from young men not desiring to be educated.

The chief function of an undergraduate institution is instruction, and its faculty should be chosen with this in view. Every such teacher, however, to attain his highest efficiency, should engage in some kind of research, that is, getting new information at first hand. This can not fail to have a vitalizing effect on his teaching, keeping clear the distinction between fact and theory, and maintaining his instruction abreast of the times.

There is questioning of the value of much that is published as scientific research, and it is easy to criticize the spirit that piles up undigested data or adds to the number of chemical compounds for the sake of having something to publish; it is impossible to say, however, that any such information is and will continue to be valueless. I am less interested in discrediting such work because it now receives higher recognition from the undiscriminating in the educational world than it deserves, than I am in asking for recognition for a kind of labor, just as truly research, that now receives too scant credit from the public and from those responsible for the distribution of rewards to college teachers. I refer to what may be called pedagogical research—the labor involved in improving and constantly rejuvenating the instructional work. Any course that remains unchanged for many years is probably in need of repairs, but desirable changes usually involve much labor on the part of the instructor. The teacher whose heart is in his teaching and who carries the usual overload of duties is likely to be kept busy at just such work, and have no time left for the more conventional kinds of research, but his students will profit by his labors. The administrative officer who directly or indirectly puts pressure upon a college teacher to neglect his teaching is seriously injuring the college, yet this is by no means uncommon, intentionally or otherwise.

Research, of whatever kind, is largely a matter of inspiration, and can not be forced; as profitably might a poet be urged to become a painter as a scholar be pressed to undertake investigations foreign to his inspiration. Left to himself, the investigator will do what he is most interested in and therefore likely to do most fruitfully; to attempt to force a teacher whose instincts are for pedagogical research to other kinds of investigation is likely to spoil a good teacher and make a mediocre investigator. The method of forcing commonly practised is the indirect but very effectual one of recognition of published research by promotion and increased remuneration, while devotion to teaching and pedagogical research receive no such rewards.

Let us recall our own undergraduate experiences. Did we not in many cases get most stimulation and make most progress under teachers unknown in the professional journals? It is to be expected, indeed, that the teacher whose chief pride and interest are in his teaching, and whose chief reward is the advancement of his students, should be of more real value to those students than the investigator whose hours of reflection are devoted to the problems of his research, and to whom the instruction of classes is incidental, if not, as in many cases, an unwelcome interruption. Gifts of an equally high order for instruction

and for investigation are not usually found in the same individual, let each give his main effort to what he can do best, let the investigator work with mature students and the teacher with the immature, and let the distributors of rewards make no invidious distinctions in the recognition of the two equally necessary and meritorious services.

It is eminently desirable that a teacher should be also an investigator; in every faculty, however, some members have more pronounced ability than others in this direction, and it is proper that such should receive special consideration as to other demands upon their time and attention in order to enhance their productiveness by favorable conditions. To the others, whose bent is less marked in the direction of research, should be assigned the duties of administration and the committee work, with, if necessary, the high school commencement addresses. Neither should the more general business of the college be regarded as of any less value or importance than research, or less worthy of reward. To be sure, it has not the same advertising value, but an institution of learning should be above adopting the motto "quick returns and small profits." The most enduring good accrues to the students, and therefore to the college, from inspired teaching and wise and careful administration.

It is certainly the part of wisdom to provide as favorable conditions as circumstances will permit for the encouragement of research. Several factors more or less obvious enter into this favorable environment and influence the productiveness of the investigator, but the real determining factor is in the man himself; he must have ideas, enthusiasm and industry, he may even be a crank, he must have an accurate memory to retain the results of extensive reading, and as much as any one can profit by good health, to withstand the strain of concentrated and continuous effort; he must be absolutely honest with himself and the professional world. If he has the necessary qualities it is very unfortunate if his circumstances do not permit their most fruitful activity, if he has not, let him serve his institution in other ways for which he is better fitted—ways of equal importance. Few men can spend several hours daily with classes, several more in administrative work, one or two more in committees, and have any vitality left either for research or professional growth.

The greatest need of most successful college teachers is more time to think. The evil effects of the prevalent rush become apparent only very slowly—in the course of years—in a gradually failing effectiveness for lack of mental nourishment. No one can use a few minutes now and then, snatched from the more urgent duties of the moment, to do or even think real research, ideas do not come on demand, interruptions are often fatal to inspiration, experimental work often must be continuous to lead to results, investigation that is worth while is not a routine operation to be started and stopped by a gong; there must be mental growth as a background. It would probably be economical in the long run if the real teacher-investigator could be assured of uninterrupted privacy for half of every day.

In addition to time for thought, reading, experimentation and writing, the teacher of science needs space and material equipment. There is a temptation to spend money most freely in ways that lead to the most tangible results, and would-be benefactors may cause serious embarrassment by providing buildings without equipment or endowment; blessed be the liberal contributors to the "gen-

eral fund," meaning equipment and, most important of all, competent men

In the providing of suitable buildings with limited means, circumstances must decide how much can be devoted to what may be called luxuries and quality as against necessities and quantity, it is certainly desirable to have buildings as beautiful as possible, but not at the expense of adequate size and equipment

Books are too often a crying need, they cost so much and they show so little; and yet without them research is impossible The most serious lack is usually that of complete files of the scientific journals, which can *never* be purchased on a non-accumulating allowance of a hundred dollars a year The value of the library habit to the student can hardly be overestimated, but to develop this plenty of books and an attractive place for reading them are almost indispensable How welcome to the business manager of many a college in straitened circumstances would be the professor who "did not read books but wrote them"

Turning now to the question of assistance, from the purely business standpoint, a man should not be required to do what a cheaper man can do as well; the problem, however, is by no means solved by so stating it The profitable use of assistants is a far from simple matter, their duties should be so assigned and supervised that their time may be spent to the advantage of the department and also to their own obvious profit The men available have usually recently graduated and should realize that the salary is not the chief reward for their services, but that the time spent as an assistant in a well-conducted department is valuable as a period of education and necessarily precedes any more advanced position in the college or university world. The assistant should welcome all such experience, even if some drudgery is included, as gives him an insight into the teaching of his subject and the management of departmental business, such as the handling and ordering of supplies, the administration of classes, and the keeping of systematic records To really review and extend his knowledge of the fundamentals of his subject so as to meet the needs of students entitled to his help is no slight task, but the assistant should use his utmost efforts towards progress in more advanced study and in research if his preparation is adequate The assistant who shows the right qualities will not long fail to receive recognition and promotion; in the teacher's profession "everything comes to him as can wait" as far as he has the qualifications Given the natural ability, industry and personality, thorough preparation will compel success, an assistant's position in a large and efficient department in association with successful men is better preparation for ultimate success in college or university work than the better paid positions in high schools open to men of equal training

Those having charge of assistants should see to it that there is opportunity and encouragement for proper growth It is through such assistants that the older teachers may hope to accomplish research, in doing which both are equally benefited It is, however, something of a deception to call such assistants' positions "fellowships" if the duties of the department occupy any considerable part of the time

It is certainly desirable that the more experienced teacher should delegate to assistants such of his work as can be properly done by them, it is very undesirable that he should cease to have direct and constant contact with the work of students, the direction and development of courses should remain actually in his

hands and the work of assistants be under constant scrutiny. When it becomes impossible for a course to continue actually under the direct management of a senior instructor it should be placed in charge of a qualified associate whose responsibility will be the incentive for his best work, the plan followed in some universities of having courses nominally in the hands of those for whom it is impossible to actually direct the work, which is really done by junior men, is essentially unfair to the latter, in withholding from them the credit to which they are entitled, not conducive to the best results in that it fails to provide the incentive for devoted effort on the part of those actually planning and administering the work, and an imposition on the college and the public, who believe the courses to be really administered by the more widely known teacher. Many a student has been disappointed in finding that he has little or no contact with the man advertised as having the work in charge.

In growing institutions it is the usual experience of the teacher that other duties encroach more and more upon his instruction and research, the latter being first sacrificed. Some of these are indispensable, such as the keeping of accurate records of students' work, and as institution and department grow there is some unavoidable increase in the machinery for handling students, the red tape and machinery should be recognized as a necessary evil—a means not an end—and kept at a minimum, if the choice were imposed between good teaching with no records and good records with no teaching, the election would be simple. There may be a conflict of opinion on this subject, however, between the engineer of the beautiful machine and the poor laborer whose energies are consumed in feeding it with reports. I believe that we devote too large a part of our attention to the lazy and incompetent, to the detriment of the more energetic and able students, on account of the struggle for the prestige accorded to numbers, which we may also charge with the use of colleges as lounging places for the sport and the intellectual dead-beat. It is surely unfortunate if a teacher has to spend his time in keeping elaborate records of and forcing the loafers instead of stimulating and satisfying the gifted.

The question of salary has an intimate bearing upon the efficiency of college teachers, and it is generally admitted that they are underpaid. The cost of living varies so widely in different college towns that a salary adequate in one would be entirely insufficient in another, so that it is impossible to name a suitable salary. As a general principle, however, it may be accepted that the remuneration should be enough to attract men of energy and ability and make possible their best work. It is not desirable that teachers should vie with the commercial classes in display or in expensive amusements, and men of intellectual strength would not wish to, it is proper that they should receive enough to permit comfort without anxiety, membership in scientific societies and the opportunity to attend their meetings, books and other professional tools, and also travel, society, and the enjoyment of music and art, for the sake of their own broad development and consequent influence in society as well as with their students. The man who never sees anything but his home and his place of business is certain to be narrow. Many young men ruin their professional prospects by marrying on a very small income even before their education is complete; it is no evidence of a lack of sentiment for a man to postpone marriage until he is in a position to properly main-

tain a family. Further, it is surely the cause or the result of second-rate qualifications as a college teacher to attempt to carry on another business with no bearing upon his professional pursuits for the sake of the increased income. Scarcely less valuable is the semi-professional routine of tutoring, commercial analysis, and even the preparation of uninspired text-books, for the same reason. These things do not give the best preparation for and naturally do not lead to the highest university positions, though they do bring immediate financial reward; better far devote the time to some research if there is any in the teacher, and qualify for advancement in the college or university world. In education as in business, both the teacher and the institution may expect to get what has been paid for; if the teacher gives less than his best efforts he may look for less than a full reward, and the institution that seeks bargains in teachers will probably get something cheap—and nasty; if first-rate results are to be achieved the price of first-rate ability must be paid, allowing for a long and expensive preparation.

The bearing of this upon the question of research is evident; to cultivate the vitality of the intellect it must be free—free from anxieties as to the necessities of life, free to proceed in broad and deep channels, with all the incentives of intercourse with things intellectual and esthetic.

The story is told of a college teacher, who was conspicuous at prayer meetings, that it was his custom in closing a lengthy petition covering a large amount of detail to say, "And now, O Lord, to recapitulate," and so on.

Permit me, then, in conclusion to summarize the points I have tried to present. In undergraduate schools research has a very important place as a stimulator and vitalizer of the teaching; it is, however, a secondary calling and should not be allowed to interfere with the main function of the undergraduate teacher, namely, instruction. The selection of men for such positions should be based primarily on their qualifications as teachers, and research should not be undertaken until a broad and deep foundation has been laid. The value of research, however, makes it most important that men capable of doing it should be helped in their efforts by the most favorable environment possible.

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A PLEA FOR ORGANIZED RESEARCH IN THE TROPICS

As science progresses we begin to look for new fields of research, for an increased sphere of investigation, for a greater and more varied amount of facts upon which to base our generalizations and our conclusions. As modern development generally becomes more pronounced we begin to reach out for opportunities in new regions, in those parts of the world where civilization has not yet gained a final foothold. To-day the tropical countries are still comparatively unknown, forming a terra incognita which contains many secrets for the explorer, many problems to be solved by the scientist, many riches to be gathered by the pioneers, always ready to exploit the resources of new regions.

With the striking diversity in their natural productions, their variety of geological structure, and their extreme conditions of climate, the tropics offer, in most branches of natural science, exceptional opportunities and wide fields for investigation and research.

Scientific research in the tropics has been carried on in a more or less perfunctory manner. Tropical research generally has not been conducted in a really scientific way. There is no organized and systematic investigation of tropical conditions, with the exception of a few years' work in this direction in Java and the Philippines.

I hasten to explain the above statements which at first sight may appear too sweeping and too severe It is true that by individual and public effort, in the eastern tropics, in India, Ceylon, Malaya, Java and the Philippines a large amount of scientific research on tropical subjects has been accomplished from time to time. Vast quantities of valuable observation have been accumulated, but we still lack scientific data from many other parts, without which we can not arrive at definite conclusions It is equally true that many individual scientists and scientific explorations have penetrated the swampy forests of the Amazon and the Orinoco, have marched over the pampas of Brazil and the llanos of Peru, have paddled up the affluents of Magdalena and Marañon rivers, climbed the snowy peaks of the Andes under a tropical sun, dwelt on the fever-infested sands of the Mosquito coast or sweltered in the dampness on the slopes of the Central American volcanoes, but all this work has been accomplished without a comprehensive plan or a definite purpose in view as to a final understanding of the conditions of the tropics. This pioneer work is most valuable, it has shown us what a marvelously rich field for research is to be found in the tropics.

The old European nations with tropical dependencies realized long ago that the successful opening up of their colonies depended on a proper knowledge of their resources. From the time of Linnæus, who sent many of his pupils to tropical countries, to that of the Honorable East India Company, from the time of Captain Cook's first voyage, when Banks and Solander gathered such valuable data, up to the present day the collections from the tropics have been mainly of an economic nature. These collections have been stored and studied in European and American scientific institutions, generally by scientific men who have not themselves had the opportunity of travelling in the tropics. Where such studies have been made on living specimens the latter have been kept under artificial conditions, which seldom if ever give a true imitation of the real natural surroundings such as they exist in the tropics.

The most important among such institutions in Europe is Kew, with its gardens, hothouses, museums and herbarium. By being the central place of tropical botanical research for the British colonies, as well as a school of tropical horticulture, which has produced a great number of scientific men for Great Britain's tropical dependencies, Kew has rendered tropical science invaluable service.

The Imperial Institute in London, in later years, has commenced to investigate colonial products more closely than was possible at Kew, and the brief but useful work of the Liverpool Institute for commercial research in the tropics indicated the lines upon which tropical investigation ought to be conducted The Liverpool School of Tropical Medicine through the investigations of Ross and others deserves the highest praise.

We find in India numerous scientific institutions for tropical research, and in the British colonies generally the botanical and acclimatization gardens have become features of the greatest importance Of British tropical gardens in the East, those in Singapore, Peradeniya, Calcutta and Kamerunga are especially noteworthy for their services to botanical science in general and to tropical agriculture in particular. The German, Brandis, organized Indian forestry on a scientific basis, which is not surpassed even by the work of Pinchot in this country, and the investigations in recent years at the Dehra Dun Forest Research Institute are unique in their thoroughness and value. It took an American to establish Indian agricultural research on a modern footing, and the Agricultural Research Institute at Pusa is now recognized as one of the leading institutions in the east.

The small acclimatization gardens in Brisbane, Port Darwin, Perak and Bangalore have been very useful in their way.

Holland found that the material progress of its colonies depended on the scientific development of agriculture, forestry, mining and other industries. With characteristic

thoroughness the Dutch set about the study of their colonial resources. The botanic garden at Buitenzorg with its many accessory institutions remains easily the leading one in the world, and the monumental work of Treub, whose recent death is a great loss, as an organizer and scientist can not be overestimated. His agricultural department of the Dutch East Indies was probably more efficient than any similar institution in the entire world.

The new development of the black continent has led to increased activity in the investigation of its scientific problems. Many new institutions of research have been founded, both in British, German, French, Belgian and Portuguese colonies in tropical Africa.

While the eastern tropics and their resources are comparatively well known, we have a very scant knowledge of the tropics of the western hemisphere.

Besides the few scientific institutions in the British and Dutch West Indies, and in Brazil, there are no botanical gardens, no agricultural experiment stations, no meteorological observatories, no medical research institutes, no zoological laboratories in the American tropics. In all the large territory of Central America, in Colombia, Venezuela, Ecuador and Peru there is absolutely nothing being done in scientific research of the tropics.

The United States of America have in recent years acquired valuable tropical dependencies, and in Porto Rico, Hawaii and the Philippines, notably in the last, scientific investigation is receiving due attention, in accordance with the requirements for scientific knowledge characteristic of present-day America.

The people of this country are, however, interested also in other parts of the American tropics, even if these are not political dependencies of the United States. It is sufficient to recall the fact that over a billion dollars of American money are invested in the tropics, in order to realize this. The American people investing in the tropical industries of the equatorial regions of this hemisphere have not had the assistance of science in making their investments secure and profitable. How different are conditions in Great Britain! America has been so preoccupied with the development of its own enormous resources that the tropical parts of this hemisphere have been left to work out their own destiny unaided.

The Monroe Doctrine as an expression of the homogeneity of all interests affecting America should cease to be a political theory only, and should be brought down to commercial, industrial, literary and scientific reciprocity between the American countries. Trade relations are becoming more intimate. It is time that scientific relations become more frequent.

Tropical America is to-day more European than American. For centuries maritime Europe has been trading with the American tropics, supplying immense amounts of capital for the development of their vast resources, and converting these countries into commercial, if not political, dependencies.

To this day Europe has done more for the scientific exploration of tropical America than American scientists. There is, fortunately, no Monroe Doctrine as regards American science. But thoughtful Americans can not but lament their country's neglect of the great opportunities for contributing to the progress of civilization in tropical America.

Every country in the world needs the products of the tropics. Those that have not tropical dependencies of their own must acquire such products from other countries. The requirements of a prosperous nation of 90,000,000 of consumers have created a great market for tropical products in the United States. Humanity in general derives to-day many products from tropical countries, which have become articles of daily need where a century ago they were luxuries.

Tropical America, with its vast areas of fertile land, its abundant rainfall and perfect climate, and its proximity to the world's largest market, is capable of supplying all the products of the tropics in enormous quantities.

To be able to take advantage of these conditions, it is of the greatest practical importance that we arrive at a better and proper understanding of tropical countries.

The aid of science is necessary to make the tropics habitable and productive. Academic as well as applied science has in the tropics an open field But we need organization and systematic work, instead of haphazard skimming of the surface of the scientific treasures of the tropics

Where the problems are legion, and where the material is as abundant, and the opportunities as frequent as they are in the tropics, it is a general failing of the scientific worker that he becomes interested in too many features to be able to do his best. This must be avoided

With the exception of the botanic gardens at Buitenzorg there are no scientific institutions in the tropics adequately equipped or properly manned The usual small institution with a staff of two or three scientific men, often hampered by demands on their time for work in applied science, can accomplish but little The need of a large institution for the investigation of tropical America becomes apparent when we take into consideration a few of the scientific and practical problems, which in thousands are waiting to be solved in the tropics.

The riches of tropical countries were the incentive which led to the great discoveries of unknown lands They furnished the principal motive for the travels and discoveries of Columbus, of Balboa, of Vasco di Gama, of Dampier and Captain Cook, of Bougainville Humboldt made his most acute observations while following the Cordillera through the American tropics Darwin and Wallace collected their most important evidence in tropical countries for the theory of natural selection Huxley, and Agassiz, father and son, acknowledged the value of their tropical journeys for their work

The educational value to the young naturalist of tropical travel is now well recognized It is to be hoped that an American institution for tropical research will make it possible for every young scientist of this great country to study for some time at least the peculiar conditions of the tropics and to contribute to the knowledge of tropical phenomena, by travel and investigation

The conditions of life in the tropics as far as prevailing external conditions are concerned, are favorable to the development of a multitude of individuals, and consequently there is such a severe struggle for existence as is entirely unknown in more temperate climates The many problems arising from this fact can not be studied to better advantage elsewhere.

There is no better place for a study of plant geographical problems than in the undisturbed regions of the tropics

Systematic observations of the phenological stages and similar features of tropical plants in their natural surroundings have yet to be undertaken

Very little work on the ecology of tropical plants has so far been done This should be undertaken in the tropics The hothouse method of studying plant phenomena is not reliable. Instead of showing the development of the tropical plant in its natural surroundings, it rather indicates the adaptability of the plant to unusual conditions and the possibility of acclimatization The plants can not be placed under natural conditions in artificial temperatures.

The plant pathologists will find the tropics teeming with lower forms of life preying upon vegetation, and work on these lines is in great demand and of immense practical value

The relation of plant life to geological conditions, the work of plants in changing the topography of the earth's surface, are equally interesting to the botanist and the geologist, and very little is so far known upon these questions from the tropics

While in cold regions there is a retardation of development of plant life caused by low temperatures, in the tropics the same effect is caused by variation in moisture. The latter factor controls plant life in tropical regions, while in temperate portions of the earth heat is the principal factor influencing vegetable phenomena. Thus the dry season in the tropics corresponds to the winter in other parts, it is the time of rest and death. These relations are as yet but little understood in the tropics

While light and the incident sunshine fur-

nish the mechanical or molecular energy at the disposition of the plant, they are the least understood of the climatic elements. In the tropics the light conditions are very intense and for this reason actinometric studies are especially necessary in tropical countries.

As for the chemical intensity of light, such comparative work as that of Roscoe and Thorpe in England, Portugal and Brazil opens up most interesting vistas of research.

While we have valuable results from temperate climates in regard to the relation of plants to soil moisture, evaporation and associated phenomena, we know practically nothing about these conditions in the tropics.

We know that in the tropics the average annual temperature differs but little, while the quantity of precipitation differs largely. The latter feature is of greater importance and needs therefore special study. We have a large amount of scattered data and much generalization, but practically nothing of definite scientific or practical value.

Tropical soils are as yet very little studied, except in a few localities, as in the West Indies, British Guiana and Java. The rapid decomposition of rock caused by the combination of abundant moisture and heat furnishes new layers of soil as well as a fascinating subject of study for the geologist and the chemist.

The numerous vegetable products of the American tropics are as yet very little known from a scientific point of view. There are scores of tan barks, dozens of oil-producing plants. New rubber plants are found frequently in the neotropical regions. New and old tropical fruits invite study, and economic plants generally occur in abundance.

When we consider that tropical America has given mankind more economic plants than any other part of the world, it seems strange that, after all, tropical America is less known to-day than any other region of the earth. We may only mention corn, potatoes, cacao, tobacco, rubber, sisal hemp, vanilla and probably bananas among the important vegetable products of the western hemisphere.

There is an open and very profitable field for the plant breeder in improving tropical products.

The tropics are inhabited by peculiar and interesting races of mankind, and traces of ancient civilizations are now obliterated by a luxuriant forest vegetation, which clothes the tropical lands from the level of the sea to the summits of the loftiest mountains. The anthropologist and the ethnologist find in tropical America some of the most complicated and interesting problems of research.

It is in the tropics where the principal volcanic belts encircle the globe, and with their variety of geological structure, their frequent earthquakes, their coral formations bathed by the tepid waters of the great tropical oceans, the tropics of America offer unequaled opportunities for geological studies.

The violent electric discharges in the tropics produce atmospheric nitrogen, which probably is carried by the rain water into the soil, and thus contributes to and probably explains some of the fertility of the tropical soils. Our knowledge in this regard is very limited.

Where the tropics teem with vegetable products of the most striking diversity, animal life also is most abundant and of great variety. Tropical zoology is so far only touched on the surface, and especially are the lower forms of animal life in the equatorial zone known only slightly.

The pathogenic bacteria have only in a few instances been investigated and a large field is here open. There has been much progress in tropical medicine during late years, but while we know the elements of this science there is still much to learn, many tropical diseases to study and many remedies to discover.

Modern science has demonstrated that life in the tropics is possible for white man, and if ordinary precautions are taken he is as safe there as in any other place. Tropical exploration has craved its dues in form of many martyrs to science, but with modern appliances and present-day knowledge there is no need of privations and exposure during tropical travels.

In this regard it is of special importance that systematic research in the tropics be

inaugurated, so that scientific workers may receive proper instructions and advice as to methods and conditions of life and travel. Instead of gathering his own experience in this regard he should be able to rely on that of others, and without waste of time devote himself to his scientific work. Every scientific investigator in the tropics knows that the information he received when he prepared for his journey of exploration into the primeval forest was practically valueless, and he had to learn for himself, often at considerable expense, loss of time and not infrequently of health.

An international, a Pan-American institution for the scientific study of the conditions of tropical America is needed. American scientists should take the lead and invite their colleagues of the Latin-American republics to join them in a systematic endeavor to study the tropics of this hemisphere, its natural riches and its diversified conditions Such a course will be as important for the preservation of peace, for the mutual understanding between the peoples of the Americas, and for the progress of these countries as commercial treaties or diplomatic conventions.

I do not propose here to enter into details in regard to the organization of a Pan-American scientific institution for the systematic study of the American tropics I do believe that the time is ripe for such an undertaking, and I have reason to think that if a suitable plan is defined and proposed it will meet with the ready response and approval of the public and the governments of all the American republics.

PEHR OLSSON-SEFFER

TEZONAPA BOTANICAL STATION,
MEXICO, D F,
December 20, 1910

OCTAVE CHANUTE[1]

OCTAVE CHANUTE was born in Paris, France, February 18, 1832 He was brought to this country in childhood, was educated chiefly in New York City and began the practise of his profession as civil engineer at an early age.

After having done efficient work in railway construction in New York, Indiana and Illinois, he became in 1863 chief engineer of maintenance of way and construction of the reorganized Chicago and Alton Railroad, remaining upon that line until 1867.

During this connection, having been invited to submit a design for the proposed Union Stock Yards of Chicago, his plan was selected in competition with a number of others and he built these yards as chief engineer He was also awarded a premium for a competitive design for a bridge across the Missouri River at St. Charles, Mo. In 1867 Mr Chanute went to Kansas City, Mo., as chief engineer of the bridge across the Missouri River at that point. This was the pioneer bridge across the Missouri River, and as the river pilots and riparian dwellers had given this stream a bad reputation, the successful completion of this bridge across it in 1868 attracted great attention and interest

Later Mr Chanute successively became chief engineer of the Kansas City, Fort Scott and Gulf, the Kansas City and Santa Fe, the Atchison and Nebraska, and the Leavenworth, Lawrence and Galveston railroads

From 1873 to 1883 he was in the service of the Erie Railway as chief engineer. During this connection he readjusted the motive power of the road and lessened the grades so that the through freight trains, which averaged eighteen cars when he first became connected with the line, had grown to thirty-five cars when he closed his connection with the road in 1883, when he removed from New York to Kansas City, in order to look after his personal interests, and to open an office as consulting engineer.

In this latter capacity he took charge of the construction of the iron bridges during the building of the Chicago, Burlington & Northern Railroad between Chicago and St Paul in 1885, and of those of the extension of the Atchison, Topeka & Santa Fe Railroad, from Kansas City to Chicago, in 1887 and 1888; the latter involving, besides a number of minor streams, the Missouri River bridge at Sibley

[1] Presented to Section D, American Association for the Advancement of Science, Minneapolis, December 30, 1910.

and the Mississippi River bridge at Fort Madison.

In 1889 Mr. Chanute removed his office to Chicago, where he engaged in promoting the preservation of timber against decay, by chemical methods.

Mr. Chanute became a member of the American Society of Civil Engineers, February 19, 1868, and has contributed a goodly number of papers to its *Transactions*. In 1891 he was president of that society, in 1901 he was president of the Western Society of Civil Engineers, and was honorary member of similar societies in England, France and Chile

In October, 1891, there appeared in *The Railroad and Engineering Journal*, of New York, the first of a series of articles on "Progress in Flying Machines," written by Mr. Chanute The series was extended in the next two or three years, and in 1894 was published in book form under the above title It is a volume of over three hundred pages and it tells both of failure and progress. The author, bringing all of his resources as a skilled engineer to bear upon the unsuccessful experiments, analyzed all of the more important work done by scores of men and tried to point out, as much as might be, the causes of failure.

In the preface to the book it is stated that one of the writer's objects in preparing the papers was "to satisfy himself whether, with our present knowledge and appliances, men might reasonably hope to fly through the air." He said that in his opinion "this question can be answered in the affirmative" It meant much to the believers in the possibility of mechanical flight to have the endorsement of an engineer of the highest standing given to a discredited line of research.

In 1892 Dr. A. F Zahm, of Notre Dame (Ind) University, now of Washington, D. C., proposed the holding of an International Conference on Aerial Navigation in connection with the World's Congress Auxiliary of the World's Columbian Exposition of 1893.

In this Dr Zahm was heartily seconded by Mr. Chanute, who was made chairman of the committee, Dr Zahm being chosen secretary. The officers of the World's Congress Auxiliary, of which Mr. C C. Bonney was president, gave cordial cooperation to the plan.

The conference formed a division of the General Engineering Congress and took place in the Memorial Art Palace, in Chicago, August 1, 2, 3 and 4, 1893. It was the first aeronautical congress held in America, and the third international one

Mr. Chanute presided over the session on the opening day, the topic for the day being "Scientific Principles" In opening the conference he said

It is well to recognize from the beginning that we have met here for a conference upon an unusual subject; one in which commercial success is not yet to be discerned, and in which the general public, not knowing of the progress really accomplished, has little interest and still less confidence

The paragraph just quoted well shows the status of interest in aerial navigation in 1893. Though peculiarly conservative Mr Chanute expressed his conviction that dirigible balloons would presently attain a speed of twenty-five miles an hour, an estimate which is fully justified by subsequent events. He likewise maintained the practicability of achieving mechanical flight by gradual evolution, utilizing the results of the accumulated labors of many scientific contributors. He indicated the chief component problems already solved and awaiting solution "The equipoise," said he, "is, in my own judgment, one of the most important problems yet to be solved in aviation"

The papers read at and contributed to the conference fill a volume of more than four hundred pages. The attendance averaged about one hundred at each session, comprising the most prominent men in the engineering profession.

In the summer of 1896 Mr. Chanute began his now well-known experiments on the sand dunes with man-carrying gliders. These were continued in the following year. The accounts of this very important part of his work have been fully given in various magazines and pamphlets.

Beginning with the glider of the form which had been used by the German, Lilienthal, two

years of study and experiment enabled him to produce a type having great superiority in the matter of stability, efficiency and structural strength This was the famous Chanute biplane glider which substantially forms the conspicous body feature of the present-day biplane flying machines

For many years Mr Chanute was in regular communication, personally and by correspondence, with the leading aeronautic investigators in both hemispheres The help which he gave to such men can never be fully known, the counsel and encouragement which he gave the Wright brothers in particular have been gratefully and gracefully acknowledged by them His valuable experience, information and advice were liberally and gladly furnished to them at the time when it was most needed, when they were at the foot of the unblazed trail, and these gave them the courage and confidence which were essential to enable them to persevere and to emerge at last at the summit, triumphant

At the Boston meeting of the American Association for the Advancement of Science, held in December, 1909, Mr Chanute read a paper entitled "The Present Status of Aerial Navigation" This paper was the expression of his maturest understanding of the science to which he had devoted so many years of his life

Mr. Chanute died in Chicago on the twenty-third of November last Three daughters and one son survive him. Those who knew him will always remember his lovable character and will think of the oft-repeated saying, "He was more willing to give credit to others than to claim any for himself"

We may well believe that whenever in the future the history of aviation shall be reviewed, the name Chanute will stand forth as that of one of the few great founders

James Means

Boston, Mass

THE AFRICAN ENTOMOLOGICAL RESEARCH COMMITTEE

With a view to furthering the work of the African Entomological Research Committee, Mr Andrew Carnegie has placed at its disposal a sum of £1,000 a year for three years to defray the cost of sending a few suitably qualified young men to the United States to study the practical applications of entomology. Three of these Carnegie scholars, as they are to be called, have been selected, and two of them are already at work Dr L O Howard, chief of the Bureau of Entomology, is interesting himself in the matter and all possible facilities will be given to the scholars It may be expected that the scheme will be of value to British administration in Africa and elsewhere by providing a body of well-trained entomologists available for employment in the services of the different colonial governments

The Research Committee was appointed in June, 1909, by Lord Crewe, the then Secretary of State for the Colonies, with the object of promoting the study of the insects which play so prominent a part in the spread of disease among men, animals and plants in Africa, and Lord Cromer is its president It includes some of the most eminent authorities on entomology and tropical medicine in Great Britain

During the short period of the committee's existence satisfactory progress has been made The scheme has been energetically taken up by the African colonies and protectorates, and the large quantity of material already received at the committee's office in the Natural History Museum at South Kensington has very materially increased our knowledge of the insect pests of Africa The collections of insects, after being properly identified and recorded, are being distributed to the schools of tropical medicine, universities, museums, or other institutions where they are likely to be of value for the purpose of teaching or scientific study. Two skilled entomologists are being employed under the direction of the committee in East and West Africa respectively, for the purpose of interesting and instructing the local officials in the work, and also of carrying out special investigations.

The committee has issued quarterly a scientific journal, entitled the *Bulletin of Entomological Research*, of which the first volume is

just completed Further particulars may be obtained from the secretary of the committee, Mr. Guy Marshall, British Museum (Natural History), South Kensington, London

SCIENTIFIC NOTES AND NEWS

As a result of the recent tentative agreement between Columbia University and the Presbyterian Hospital, New York, the appointments of Dr Theodore C Janeway as attending physician and of Dr William G MacCallum as pathologist to the hospital have been announced Dr Janeway is professor of the practise of medicine in the College of Physicians and Surgeons and Dr MacCallum is professor of pathology They succeed Dr W Gilman Thompson and Dr Eugene L Opie, respectively, at the hospital

AT the last meeting of the Rumford Committee of the American Academy of Arts and Sciences the following appropriations were made To Professor D F Comstock, of the Massachusetts Institute of Technology, $100 in aid of his research on the possible effect of the motion of the source on the velocity of light To Professor G N Lewis, of the same institution, $150 in aid of his research on the free energy changes in chemical reactions To Professor R W Wood, of the Johns Hopkins University, $150 in furtherance of his researches on the optical properties of vapors

THE following fifteen candidates have been nominated by the council of the Royal Society for election to membership Professor H T Barnes, Professor A. J Brown, Professor J B Cohen, Professor W E Dixon, Professor F G Donnan, Major E H. Hills, Dr. W H Lang, Professor J B Leathes, Professor E A Minchin, Professor R. Muir, Mr. R. D. Oldham, Mr. R I Pocock, Professor A W Porter, Mr. H W Richmond and Mr. G G Stoney

M. EUGÈNE TISSERAND has been elected a member of the Paris Academy of Sciences in succession to the late Professor Tannery

THE *British Medical Journal* notes various honors conferred on Dr Paul Ehrlich, director of the Institute for Experimental Therapeutics at Frankfort. The Emperor of Russia has conferred upon him the Order of St Anne First Class, with a badge set in diamonds The King of Spain has bestowed on him the Grand Cross of the Order of Alfonso XII The German Emperor has nominated him a member of the senate of the recently founded Kaiser Wilhelm Society for the Advancement of Science, on this body he is the only representative of medicine The St Petersburg Institute of Experimental Therapeutics has elected him an honorary member The municipal authorities of Buenos Aires have given Professor Ehrlich's name to a street in the suburb of San Fernando.

A PORTRAIT of Sir William Crookes by Mr E A Walton, as we learn from *Nature*, was presented to the Royal Society before the ordinary meeting on February 16 The presentation was made on behalf of the subscribers by Professor Meldola representing about 130 fellows of the society who had contributed to the fund Sir Archibald Geikie, as president, accepted the portrait on behalf of the society Sir William Crookes expressed his thanks to the subscribers for the honor they had conferred upon him In the course of his remarks he said that in two years he hoped to celebrate the jubilee of his fellowship, as his election dated from 1863

PROFESSOR W W WATTS, F R S, has been elected president of the Geological Society of London The following awards of medals and funds have been made. Wollaston medal, Professor Waldemar C Brøgger, Murchison medal, Mr R H Tiddeman, Lyell medals, Dr F A Bather and Dr A. W Rowe; Bigsby medal, Professor O Abel; Wollaston fund, Professor O T Jones, Murchison fund, Mr. E S Cobbold, Lyell fund, Dr C G Cullis; Barlow-Jameson fund, Mr J F N Green.

WE learn from *Nature* that the Lannelongue prize, founded last year by Professor Lannelongue, of Paris, has been presented to Sir Victor Horsley, F R S The prize is a gold medal and the sum of $1,000, and it is awarded to the person who had contributed most to the progress of surgery in the ten years before the date of the award. It is open to surgeons of all nations, and is to be

awarded every five years during the annual meeting of the Société de Chirurgie.

The Fothergillian gold medal, of the Medical Society of London, given triennially, has been awarded to Dr. F. W. Mott, F.R.S., for his researches on the nervous system

President Schurman has been appointed by the faculty and trustees of Cornell University a delegate to the celebration on September 12 to 15 next, of the five hundredth anniversary of the founding of St Andrews University He has also been appointed a delegate to represent the university at the centenary celebration of the University of Christiania, Norway, to be held September 5 and 6

A six months' leave of absence, owing to illness, has been granted to Dr. E B Voorhees, professor of agriculture at Rutgers College and director of the New Jersey Experiment Station.

Professor Otto C Glaser, of the department of zoology in the University of Michigan, has been granted leave of absence for the academic year 1911–12

T D Urbahns, instructor of entomology at the Minnesota Agricultural College, has resigned to enter the government service. He will go to Salt Lake City to take up an investigation of the alfalfa weevil.

The appointment of Dr L Van Es as a member of the permanent commission of the International Veterinary Congress in the place of Dr. Leonard Pearson, deceased, has recently been announced. Dr Van Es is head of the School of Veterinary Medicine at North Dakota Agricultural College, Fargo, N D.

Captain Horace D. Bloomberg, of the U. S Army Medical Corps, who has been a member of the Army Board for the Study of Tropical Diseases, has completed his term of duty in the Philippines and is returning to the United States

Mr. K. R. Lewin, Trinity College, Cambridge, has been nominated to use the university table at Naples for six months from March 1.

In response to the request of the Chinese government for an international commission to proceed to China to investigate the outbreak of plague in Manchuria, the British government has instructed Dr. Reginald Farrar, one of the medical inspectors of the local government board, to proceed to China.

Dr C P Steinmetz, consulting engineer for the General Electric Company, was a guest of the University of Illinois during the week of March 6 to 11 During his stay he delivered lectures on "Electric Energy" and on "Transients"

Dr. E B Titchener, Sage research professor of psychology in Cornell University, addressed a convocation of the students and faculty of Indiana University, on February 23, on "Memory and Imagination" On the evening of February 9, the members of the Purdue chapter of Sigma Xi were the guests of the Indiana University chapter at a banquet and lecture. The lecture was given by Professor R. B Moore, of Butler College, on the subject of "The Rare Elements of the Atmosphere"

Colonel G W. Goethals, chief engineer of the Panama Canal, appeared as the ninth lecturer upon the J C Campbell Foundation of the Sigma Xi Society of the Ohio State University on February 21 A large audience gathered to hear him speak upon the subject "The Panama Canal" His lecture was illustrated by a large number of slides and also a film of moving pictures showing some of the machinery used upon the canal in operation.

Professor Charles H. Judd, director of the school of education at the University of Chicago, and Professor John M Coulter, head of the department of botany, spoke at the annual convention of the Central Kansas Teachers' Association, which met at Salina on March 2, 3 and 4

On February 10, Dr. Wallace W. Atwood, of the University of Chicago, spoke at Princeton, Ill, on "Conservation in Illinois," emphasizing the work of the State Park Commission, of which he is a member.

Sir Horace Plunkett, the Irish authority on cooperation in agriculture and member of

the English parliament, delivered an address before the faculty and students of the University of Wisconsin and the members of the state legislature last week on "The State, the University and the Farmer" He also held a conference with the members of the faculty of the college of agriculture on conditions of agriculture in America

THE Rational Geometry of Professor George Bruce Halsted has been translated into French and will be published by the firm Gauthier-Villars

WE regret to note the death of Professor Edwyn Carlos Reed at Concepcion, Chile He was director National Museum at Concepcion and had for many years studied the flora and fauna of Chile His work in natural history was largely devoted to the popularization of scientific knowledge and to the spread of economic ideas in economic zoology. He leaves one son, Carlos S Reed, who is now professor in the School of Viticulture

COLONEL R M BEDDOME, known especially for his publications on the ferns of India, died in London, on February 23, at the age of eighty-three years. The deaths are also announced of Dr. C Alexander MacMunn, of Wolverhampton, known for his research work in physiological chemistry, and of Dr. William Williams, of South Wales, an authority on sanitation

A BILL has been introduced into the general assembly of Illinois that provides for the establishment of a State Board of Forestry and a state forester It is provided that the office of the state forester shall be located at the State University and that the forester shall teach at the university.

A SOCIETY for the erection and maintenance of an institute for the treatment of cancer and for research, has been founded at Munich. The president is Prince Ludwig Ferdinand, doctor of medicine.

THE Vallauri prize of the Turin Academy of Sciences will for the coming three-year period be awarded for a work in Latin literature, for the following three-year period, from January 1, 1915, for the most important work published in the physical sciences. The value of the prize is $5,000.

THE Field Museum of Natural History announces its thirty-fourth free lecture course as follows

March 4—"Precious Stones, how they are Found and Manipulated," Dr George F. Kunz, New York City

March 11—"The Glacial History of the Great Lakes," Professor Frank Carney, Denison University, Granville, Ohio.

March 18—"The Sugar Maple and Maple Sugar Making," Professor L R Jones, University of Wisconsin

March 25—"Peking," Dr Berthold Laufer, associate curator of Asiatic Ethnology, Field Museum

April 1—"Picturesque Sweden," Professor James H Gore, Washington, D C

April 8—"The Real Filipino," Professor Arthur Stanley Riggs, New York City.

April 15—"Photographing the Heavens," Professor G W Ritchey, Mount Wilson Solar Observatory, Pasadena, Cal

April 22—"Recent Discoveries of Petroleum in the United States and Mexico," Dr. David T Day, U S Geological Survey, Washington, D C

April 29—"Turkestan, the Heart of Asia," Mr William E Curtis, Washington, D C.

UNIVERSITY AND EDUCATIONAL NEWS

THE sum of $7,000 has been received by the University of Michigan from the estate of Emma J Cole, of Grand Rapids, Michigan, to constitute a scholarship fund for graduate students in botany

THE regents of the University of Wisconsin have accepted as a trust the sum of $30,000 for the establishment and maintenance of a chair to be known as the Carl Schurz memorial professorship The chair is to be filled by professors from the universities of Germany The present size of the fund will make it possible to secure a German professor for one semester every second year. President Van Hise has been authorized to open negotiations with German authorities with a view to establishing a system of exchange professors between German universities and the University of Wisconsin. The es-

tablishment of the Carl Schurz professorship will be celebrated with appropriate exercises on March 31 The speakers on that occasion will include the two German exchange professors now in this country, Dr Max Friedlaender, of the University of Berlin, now at Harvard, and Professor Ernst Daenell, of the University of Kiel, Kaiser Wilhelm professor at Columbia

It was recently stated in this journal that among other conditional appropriations the General Education Board had made one for the Wesleyan College for women It should have read Western College for Women, an institution situated in Oxford, Ohio

The Kansas legislature has passed the bill to abolish boards of regents of three state schools and to substitute a commission of three to be appointed by the governor and to receive salaries of $2,500 a year each, to manage the State University, the State Normal College and the State Agricultural College

President James has asked the senate of the University of Illinois to appoint a committee to draft a university constitution, marking off the legitimate authority which should be given to such an institution by the legislature, defining the relations between the legislature and the state administration, on the one hand, and the university on the other, and dividing up and marking off the functions of trustees, faculties, students and alumni Among questions to be considered by such a committee would be the powers of university trustees, the function and power of the president, the duties of deans, the general division of the university itself into faculties, the authority of individual faculties The authority of the professor in his own department; his tenure of office; his independence of investigation and teaching, freedom of speech, pension system, salary schedule, method of determining the budget, powers of discipline of faculties over their own members and over their students are all subjects which would call for consideration in such a constitutional convention. It is proposed to submit this constitution, after it is drafted, to a full discussion, first in the senate, then in the university faculty, and finally, after working it out in detail, to submit it to the board of trustees, and after their modifications, to send it to the legislature for enactment into positive law

The University of Christiania will celebrate the centenary of its foundation in December next Dr W C Brogger, professor of mineralogy and geology, will preside as rector of the university.

Dr Alexander Smith, professor of chemistry in the University of Chicago and dean of the junior colleges, has been elected to the Mitchill professorship of chemistry at Columbia University, vacant by the appointment of Dr Charles F Chandler as professor emeritus

Dr Alfred Stengel will succeed Dr David L Edsall as professor of medicine at the University of Pennsylvania Dr John H Musser was unwilling to accept the position In the same institution Dr Milton B Hartzell has been appointed professor of dermatology in succession to Professor Louis A Duhring, who has recently been appointed professor emeritus Professor John B Deaver has been appointed professor of clinical surgery

At Columbia University the following have been advanced from instructors to assistant professors Hal T Beans, Ph D , and Floyd J Metzger, Ph D , chemistry; Everett J Hall, assaying, Samuel Osgood Miller, C E , drawing, Charles W Thomas, Mech E , mechanical engineering, Harry P Parr, Mech E , mechanical engineering, and Edward F Kern, Ph D , metallurgy

Dr. William McKim Marriott, assistant to the chair of physiological chemistry in Cornell Medical School, has been appointed instructor in biological chemistry in Washington University, St Louis.

Dr Pehr Olsson-Seffer, director of Tezonapa Botanical Station, has been appointed professor of botany at the National University of Mexico. He will lecture on the history of botany, evolution of plants and ecological plant geography, and give courses in plant physiology In the absence of botanical laboratories at the university, the work in plant physiology will be conducted at the Tezonapa Botanical Station Dr. Olsson-Seffer has also

recently accepted the post of Government Botanist in charge of the botanical section of the Biological Commission of the Department of Agriculture and of the Bureau of Forestry in Mexico

DISCUSSION AND CORRESPONDENCE

SOILS AND CROPS

If we accept Professor Chamberlin's view, "that the total eon of productive soils may be assigned a period of at least tens of millions of years" (as expressed in his article on "Soil Productivity" in SCIENCE, February 10, 1911, and if we accept his endorsement of Cameron's estimate for the United States that the capillary waters are carrying potassium toward the surface at the rate of from 40 to 83 pounds per acre per annum, while the total average removal amounts to only 23 pounds (20 pounds in crops and 3 pounds in drainage), then we might expect the potassium to accumulate in the surface soil at the rate of 1,700 to 6,000 pounds per acre per century, or at the rate of 17,000 to 60,000 pounds per thousand years, on normal level lands not subject to surface erosion, we might expect the surface soils to be many times richer in potassium than the corresponding subsoils, and the older soils to be much richer than those of more recent but similar origin

In contrast with these theoretical deductions the science of chemistry reveals the facts,[1] for example, that the common prairie lands of the oldest Illinoisan Glaciation contains as an average 12,470 pounds of potassium per million of dry surface soil and 14,050 pounds per million of the subsoil, that the more recent Early Wisconsin Glaciation contains 18,120 pounds in the surface and 19,650 pounds in the subsoil, and that the Late Wisconsin Glaciation contains 22,510 pounds in the surface and 26,690 in the subsoil.

The corresponding timbered soil types contain, in the oldest Illinoisan Glaciation, 15,100 pounds of potassium (per million of dry soil) in the surface and 16,050 pounds in the subsoil, while in the Early Wisconsin Glaciation the respective amounts are 18,080 and 21,100, and in the Late Wisconsin Glaciation there are 23,800 pounds in the surface and 26,100 in the subsoil, per million of dry soil

If two inches of water soak into a soil and if one inch escapes by evaporation and the other by subdrainage, the net result is not gain but loss of soluble minerals, under normal conditions In level or slightly undulating upland areas, such as the loess-covered prairies of the Central-West, which neither receive deposits from overflow nor lose partially depleted soil by erosion (especially while protected by prairie grasses), the operation of the natural law tends steadily toward soil depletion, with respect to the mineral elements, and this law has been in operation since the glacial or loessial age, wherever the climatic conditions have been similar to those now prevailing in our humid sections The accumulation of organic matter (including some phosphorus) in such glacial or loessial soil begins some time after its deposition and continues until a maximum is reached, after which the organic matter, as well as the valuable mineral elements, tends to decrease, the latter because of leaching, as from the beginning, and the former because the rate of decay finally exceeds the rate of growth or accumulation.

That phosphorus is an essential constituent of the living tissues of plants and that it accumulates in plant residues in prairie soils are well-established facts, but a theory that the phosphorus brought to the surface in capillary moisture exceeds that removed by crops and drainage is not supported by the composition of soils of similar origin and different age Thus ultimate analysis shows per million of dry surface soil 420 pounds of phosphorus in the oldest Illinoisan Glaciation, 595 in the more recent Early Wisconsin, and 705 pounds in the Late Wisconsin.

Even the theories of the federal Bureau of Soils and the estimates of the United States Department of Agriculture must be heavily discounted if they stand opposed to established facts; for one fact outweighs a thou-

[1] Illinois Experiment Station Bulletin 123 and unpublished data.

sand opinions based upon erroneous theories or estimates.

As a rule our meat is made from corn, and our bread from wheat. An average of the last five or six years compared with an average of a like period ten years before reveals the following data taken from the Year Books of the United States Department of Agriculture:

1. The average annual production of corn in the United States increased during this ten-year period from 2074 million to 2733 million bushels.

2. The average exportation of corn from the United States decreased from 177 million to 67 million bushels.

3. Consequently, the average annual supply of corn for our domestic use increased from 1897 million to 2666 million bushels—an increase of 40 per cent.

Now, if we keep in mind that every figure here given is based upon an average of at least five years, and also keep in mind that the population of the United States increased only 21 per cent. from 1900 to 1910, then we may well ask, if the supply of corn for home use has increased 40 per cent. and the population only 21 per cent., what have we done with such an enormous surplus of corn retained in this country?

A study of the statistics for wheat reveals the following data:

1. The average annual production of wheat increased during the ten-year period from 528 million to 669 million bushels.

2. Our average exportation of wheat decreased from 185 million to 110 million bushels.

3. Consequently, the average annual supply of wheat for our domestic use increased from 343 million to 559 million bushels—an increase of 63 per cent.

Here, too, we may well ask, if the supply of wheat for our home use has increased 63 per cent. while the population increase is only 21 per cent., what have we done with a retained surplus of wheat amounting to 42 per cent. above the increase in our population?

Under the Illinois laws about fifteen hundred township assessors report to the Illinois State Board of Agriculture the acreage of the various important farm crops grown in all the townships of the state. A comparison of two five-year periods, 1895 to 1899 and 1905 to 1909, shows that the average area of corn grown in Illinois increased in ten years from 6,950,000 to 7,340,000 acres, according to the assessors' returns, working under the same law during this entire period; whereas, according to the estimates reported by the United States Department of Agriculture, the Illinois corn area has increased from 6,910,000 to 9,700,000 acres. In other words, the state assessors report an increase of less than 6 per cent. while the federal report shows an increase of more than 40 per cent. in the average Illinois acreage of corn.

If we consider our three great grain crops, corn, oats and wheat, the Illinois state report shows the total average production to have decreased by 1 per cent. during this ten-year period, but the federal crop report credits Illinois with an increase of 41 per cent. in her production of grain during the same period.

For 1910 the Illinois State Board reports 281 million bushels of corn, while the U. S. Department reports 415 million bushels as the Illinois crop. Likewise the Ohio state officials report 105 million bushels, and the federal estimate credits the state of Ohio with 145 millions of corn produced in 1910.

All of these comparisons seem to reveal the influence of a strong spirit of optimism on the part of the federal department of agriculture, which, however, is supported neither by the assessors' report nor by the existence of any important reserve supplies, nor by the increased price of grain and meat and the high cost of plain living. In the last report of the United States Secretary of Agriculture it is stated that the value of our agricultural products rose from 4417 million dollars in 1898 to 8926 million dollars in 1910—an increase of more than 100 per cent. in twelve years; but shall we rejoice or weep when we consider that this enormous increase in value is not due to improvement of soil but to the estimated increase of acreage in crops and to

the actual increase in prices for food that must be paid by our own citizens?

On the other hand, even the crop "statistics" of the department of agriculture show that the average yield of corn per acre in the entire United States was 25.6 bushels for the twenty years 1870 to 1889, and only 24.9 bushels for the twenty years 1890 to 1909, an average decrease of 0.7 bushel, while the "statistics" for wheat show 12.2 and 13.6 bushels as averages for the corresponding periods, an increase of 1.4 bushels, with millions of acres of virgin wheat lands brought under cultivation. As an average the "statistics" show an increase of 7 per cent. in yield per acre for these two greatest food-grain crops; while our population actually increased 51 per cent during the same period. Curves projected from these data may not be alarming to those of the present generation who have not yet felt the high cost of living, but they look less comfortable for our own children.

True optimism is admirable, but blind optimism is dangerous. The undersigned has great faith that permanent general prosperity and progress will ultimately be secured for the people of the United States—not that kind of existence enjoyed (?) by the densely populated sections of China, which requires frequent readjustments, as now in progress[3] with the certainty of a sudden reduction in population numbered by the million; not a condition under which men and even women gather "the katamorphic products of human food-consumption" for a year, in order to recover and return to the soil an amount of phosphorus per individual equal in value to that for which we now receive at our phosphate mines only two cents from the exporter, but we seek rather a higher civilization whose achievement shall be based upon a knowledge of the fact that to insure permanent prosperity we must increase production and limit reproduction—especially the reproduction of the unfit, whose support in penal and charitable institutions already consumes about half the total revenues of the state governments.

Even though the high civilization of the ancient Mediterranean countries "went down into the dark ages with laughter," all must recognize and admire the recent agricultural developments in western European countries; but shall we ignore the fact that for five million dollars we are exporting annually to Europe a quantity of our highest-grade phosphate sufficient for the production of 1400 million bushels of wheat, that would be worth at least a thousand million dollars to the oncoming generations of Americans?

It is true that Denmark produces 40 bushels of wheat per acre, compared with 14 bushels in the United States, but Denmark produces only 4 million bushels of wheat, and then imports 5 million bushels of wheat, 15 million bushels of corn, the same amount of barley, 800 million pounds of oil cake, as much mill foods, and large amounts of phosphates, saving and using the imported fertility; and paying for it all with profit by exporting hundreds of millions of pounds of butter and bacon to a country whose degree of prosperity is measured by her profits from trading upon the prosperity and poverty of other larger countries.

The fundamental doctrine of the United States bureau of soils is indeed a pleasant one, and highly important if true, but exceedingly dangerous and condemnable if not true. It reads as follows, in exact quotations:

1. "That practically all soils contain sufficient plant food for good crop yields; that this supply will be indefinitely maintained."—Bureau of Soils Bulletin (1903) 22, p. 64.

[3] Nanking, China, February 3, 1911.—That the deaths due to famine and the pestilence following in its wake will total a million before spring was the estimate submitted to the relief committee here to-day. Relief workers are aghast with the realization of the task before them. Even were they in receipt of unlimited contributions for relief, the missionaries, doctors and other volunteer workers would be almost hopeless in the face of two and one half millions of suffering people in the Anhui and Kiang Su provinces. The famine is an old story in China, but the most experienced relief workers declared to-day that the present prospect is the worst in many years.—*From Press Dispatch.*

2. "There is another way in which the fertility of the soil can be maintained, viz, by arranging a system of rotation and growing each year a crop that is not injured by the excreta of the preceding crop"—U S Farmers' Bulletin (1906) 257, p 21

3 "The soil is the one indestructible, immutable asset that the nation possesses It is the one resource that can not be exhausted, that can not be used up."—Bureau of Soils Bulletin (1909) 55, p 66

4 "From the modern conception of the nature and purpose of the soil it is evident that it can not wear out, that so far as the mineral food is concerned it will continue automatically to supply adequate quantities of the mineral plant foods for crops"—Bureau of Soils Bulletin (1909) 55, p 79

If again we turn from theory to science, we find at the Rothamsted Station in a four-year rotation, including always a legume crop, that the yield of turnips decreased from 10 tons in 1848 to less than 1 ton per acre as an average for the last 20 years, that the barley decreased from 46 bushels in 1849 to 14 bushels as an average for the last 20 years; that the clover has decreased from 2 8 tons per acre in 1850 to less than one half-ton average since 1890, and that the wheat produced 30 bushels in 1851, and 33 bushels average during the next 12 years, but only 24 bushels since 1890, and 20 bushels per acre since 1900

As an average of the last twenty years the value of the four crops on the unfertilized land at Rothamsted is $33 83 (from four acres), but where the same crops were grown on adjoining land to which mineral plant food had been applied the average value is $76 83, the increase being 140 per cent above the cost of the minerals Let us thank God for Rothamsted, and be grateful that agriculture has some facts.

Likewise at State College, a four-year rotation, including clover, has been practised for nearly thirty years, but as an average of two consecutive 12-year periods the value of the four crops (corn, oats, wheat and hay) decreased from $44 20 to $32 72, but where mineral plant food was applied the crop yields averaged 49 per cent above the unfertilized yields

Both the teaching of science as applied to agriculture and the practise of farming, in America, have suffered and still suffer from an insufficient accumulation of facts and from an over-production of theories and conclusions

While famine is frequent in China and Russia and almost constant in India—the only great populous agricultural countries comparable with the United States in necessary self-dependence—and while the beautiful level upland Leonardtown loam soils of southern Maryland, near the city of Washington, still lie agriculturally abandoned, with only 80 pounds of total phosphorus and 500 pounds of total calcium per million in the surface soil (facts discoverable even in Bureau of Soils Bulletin 54), shall we encourage the Whitney-Cameron doctrine[6] *that it is never necessary at any time to introduce fertilizing material into any soil for the purpose of increasing the amount of plant food in that soil?*

CYRIL G HOPKINS

UNIVERSITY OF ILLINOIS

BROWNIAN MOVEMENTS AND MOLECULAR REALITY

TO THE EDITOR OF SCIENCE I have recently received a copy of Mr F Soddy's English translation of Professor Jean Perrin's paper on "Brownian Movements and Molecular Reality" Its perusal recalls to mind some ideas I have entertained for a number of years relative to a general physical theory based on very simple facts or principles The earliest record I have of these ideas is in a memorandum note of November 10, 1897. In a letter of January 30, 1900, to Professor Peter S Michie, of the department of philosophy, U S Military Academy, West Point, the ideas referred to were outlined rather more clearly and I also presented a brief statement of them under date of August 11, 1900, to the International Congress of Physics which was held at Paris in connection with the Universal

[6] Hearings before the Committee on Agriculture of the United States House of Representatives (1908), page 446; or Ginn & Company's "Soil Fertility and Permanent Agriculture," page 315.

Exposition of that year. A brief paper on the subject was presented to the American Physical Society in 1903, and an abstract of this paper was published in the *Physical Review* for April, 1903, but the complete paper with diagrams has not been published. The title of the paper was "A Simple Geometrical Principle and its Possible Significance in Connection with a General Physical Theory," and the principle referred to was stated as follows:

In an aggregation of an indefinite number of equal spherical bodies an arrangement giving minimum total volume and perfect symmetry throughout is impossible.

Three different arrangements of a group of spherical balls of equal size were considered: arrangement A, in which twelve of the balls are grouped about a central one, so the surrounding balls are tangent to the central one and to each other throughout; arrangement B, in which twelve balls are symmetrically disposed about and touch a central one, but nowhere touch each other, and arrangement C, in which the balls have the cubical arrangement, or the one in which the mutually tangent planes form cubes. The following is quoted from the published abstract referred to above:

The assumption is now made that the balls come together in a collection under their mutual attractions according to gravity laws. They will not assume or remain in arrangement C because while this gives symmetry throughout it is not the most compact possible and the equilibrium of the collection would be unstable.

Arrangement A, while the most compact possible for an indefinite number of balls in contact throughout, is not entirely symmetrical.

Arrangement B gives a perfectly symmetrical disposition of twelve balls with respect to a central ball but it is geometrically impossible throughout a collection of a greater number than thirteen.

It is suggested that under the conditions assumed the result will be that the balls will assume no fixed arrangement, but that they will be in continual relative movement, striving after the unattainable arrangement that will give minimum total volume, symmetrical disposition, and therefore fixed stable equilibrium throughout.

So far as I can now recall, I had not learned of the Brownian movements at that time. I certainly did not have this phenomenon in mind when the paper was written. I have not been able to make out that Professor Perrin's paper contains any very clear explanation of or theory as to the underlying *cause* of the Brownian movements, or that it purports to suggest such an explanation or theory, but the relations between the actual phenomenon as described and the above quoted speculation seemed to me rather striking.

In my mind the Brownian movement paper tends to confirm the idea that the "simple geometrical principle" above described is deeply significant, if it is not indeed a general and fundamental principle of physical phenomena.

JOHN MILLIS,
Col., Corps of Engineers, U. S. Army

FURTHER EARLY NOTES ON THE TRANSMISSION BY FLIES OF THE DISEASE CALLED YAWS

I HAVE previously published in SCIENCE[1] two notes on the transmission of this tropical disease by flies. The earlier reference bears date of 1769 from Guiana. The second, while of much later date (1817), indicates that in Brazil at that time the infection was conveyed by a certain fly recognizable by its small size.

Shortly after the publication of this second note, I received a letter from Professor J. B. Woodworth, leader of the Shaler Memorial Expedition to Brazil in 1908–09, in which he kindly called my attention to a further account of this phenomenon in Walsh's "Notices of Brazil." While spending the recent holidays at Washington at work in the Library of Congress, I looked up this reference and also found another and earlier statement. Believing that these accounts may not be devoid of interest and value, they are herewith reproduced.

The one referred to by Professor Woodworth is found in "Notices of Brazil in 1828 and 1829," by R. Walsh, published in Boston in 1831. On page 224 of volume I. we read:

A disease, called in the country *bobas*, is frequently attended with fearful consequences. It

[1] January 7 and November 4, 1910.

resembles the frambesia or yaws of the West Indies. The body swells and breaks out into ulcers, which have often the appearance of mulberries, and the patients become exceedingly loathsome. It is infectious by contact, but is also communicated, *according to the theory of the country*,[6] in a manner that defies all precaution. The eye sometimes is partially affected, and a small fly is then attracted by the discharge; this insect comes loaded with the contagious matter, and communicates it to the next person, on whose face he happens to light.

It will be noted that Walsh agrees with Koster's statement[7] that the disease is transmitted by a certain "small fly from which every precaution is oftentimes of no avail" and that the eye is the part most likely to be affected.

An earlier account of this means of infection is found in J. G. Stedman's "Narrative of a Five Years' Expedition Against the Revolted Negroes of Surinam, in Guiana on the Wild Coast of South America," London, 1796. On page 274 of volume II. he writes:

The yaws, a most disagreeable disorder, by many compared to the venereal disease, renders the patient a shocking spectacle, all covered over with yellow ulcers. To this last mentioned loathsome malady most negroes are subject, yet but once only in their lives, in which, and in being very infectious, it resembles the small-pox. Indeed, if a fly which has been feeding upon the diseased (and they are generally covered with them) lights upon the slightest scratch on a healthy person, it communicates this dreadful disorder, which always confines him for several months.

The earliest references to this disease which I have chanced upon are from William Piso. The first occurs under the heading De Lue Venerea on page 35 of his De Medicina Brasiliensi in "Historia Naturalis Brasiliæ," by William Piso and George Marcgrave. Under the heading De Lue Indica the same facts are given almost verbatim on page 43 of Book II., De Natura & Cura Morborum, Occidentali Indiæ, imprimis Brasiliæ, familiarum, in Piso's "Historiæ Naturalis & Medicæ Indiæ Occidentalis," one of the component parts of "De Indiæ Utriusque Re Naturali et Medica," by William Piso and Jacob Bont. The first was published at Leyden and Amsterdam in 1648, the second at Amsterdam by the Elsevirs in 1658.

That part of the account of the disease which is of interest to the general reader translates as follows:

Concerning the Venereal (or Indian) Disease (or Plague). This is a disease which occurs not only in children as a result of inheritance from their parents, and is contracted not only by infection in sexual union, but even by lighter contact. It originates chiefly in fetid and decaying food, and in rancid and corrupt drink. It rages not only among Negroes and Indians, but also among Portuguese and Dutch. The whole body is infested with schirrhous tumors and virulent ulcers. This disease is indeed endemic in that region [Piso was writing of northern Brazil] and by both Spaniards and Brazilians is called *Bubas*.

Careful search failed to show any reference to insects as agents of transmission.

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A THEORY OF SEX DETERMINATION[1]

Mrs. Laura A. Calhoun, a woman of culture, who has had considerable experience in the breeding of animals in California, ventures on the strength of this experience and that of others to propose and develop a theory of the conditions determining sex.

Her main thesis is set forth in these words: "The sex of the embryo in man and the higher animals is determined in the ovary from which the ovum in question is developed. In the normal female, the ovary of the right side yields ova which on fertilization develop as males, and the ovary of the left side yields ova which are potentially female."

From this arises the practical deduction that sex can be determined at will, through the service of gravitation. For the prospective mother to lie on the right side should

[6] Italics by the present writer.

[7] See "Note," etc., November 4, 1910.

[1] "The Law of Sex-determination, and its Practical Application," by Laura A. Calhoun, The Eugenics Publishing Company, New York.

ensure male offspring. To allow the spermatic fluid *to flow to the left side means female* offspring.

Besides the main thesis, Mrs. Calhoun takes up the general subject of heredity, with quotations from leading authorities, matters likely to be interesting and helpful to those for whom the book is written, much of this being addressed especially to women. A new theory, called telegyny, is suggested, the effect of the first female on the male, a theory which is probably as well founded as its prototype, telegony, the supposed effect of the first male on the female, a scantily supported hypothesis, thus far lacking adequate verification.

Mrs. Calhoun writes in a frank, modest, friendly style, which disarms technical criticism The present writer is not convinced that the theory in question is correct. But to say this is only to say that one of the central problems in biology still awaits a final decision

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QUOTATIONS

THE ANTIVIVISECTIONISTS

BECAUSE a woman, crazy about cats, subsidized a lawyer and a press-agent for an indefinite length of time, the state of New York must face every year some bill aimed at scientific research There are various organizations of this type, varying in the amount of absurdity and of harm The Society for the Prevention of Cruelty to Animals has possibly put an end to its usefulness by swinging over to the antiexperiment camp The act which has been introduced this year shows that the American societies, defeated again and again, have taken a lesson from England and are now asking for investigation instead of restriction Pasteur and Koch could not have done their work as the British law stands to-day. Of course, investigation is a plausible term. As a matter of fact, what the opponents of scientific progress object to is experiments which are fully set forth in scientific publications. Investigation would be a mere form of sentimental agitation. The scientists make no concealment of what they are doing On the contrary, they give it all the publicity they can obtain. We can hardly believe that the present is a favorable moment for these dangerous sentimentalists to succeed The death-rate from meningitis only two or three years ago was from seventy to eighty per cent. Now the rate, counting all cases, is twenty-five per cent, and in the cases where the serum is given early it runs as low as six to eight per cent Among those cases which were called cured before the serum was discovered were the long-drawn-out and most painful ones which left imbecility or some frightful deformity. These cases now have absolutely disappeared As this triumph over one of the most terrible and agonizing diseases, from which the principal sufferers are children, is so fresh in the mind of the public, it hardly seems possible that a backward step should be taken Dr Flexner and the Rockefeller Institute, in conquering meningitis, used twenty-five monkeys and about two hundred guinea-pigs and rabbits

There is one dreadful and destructive disease which men hesitate to name. It struck down not only the guilty, but millions of innocent women and millions of innocent children That disease has within a few months been mastered by a drug, the most perfect drug antidote in the world. The cost of conquering this disease was a few rabbits and a few mice.

Dr Carrel, only a short time ago, perfected the delicate operation of transfusion of blood, which is now saving many lives. The cost here was a few kittens, the societies would much rather have had the kittens put into a bag and thrown into the river

Infantile paralysis filled this country with terror a few months ago. The experiments which have taken place since then mean that this disease will be handled much better next summer, and there is every promise that before long it will be exterminated. Doubtless in the process a few animals will meet their death in the service of science, instead of in the ordinary form. There are a number of mice now suffering from cancer in order that

one of the most deadly and most painful of diseases may be conquered. The Society for the Prevention of Cruelty to Animals ought to bend all of its energies to stopping the men of science from making any use of these mice If they do not successfully interfere, it is likely that cancer may be conquered as thoroughly as diphtheria, which has been reduced from one of the most destructive scourges of children to a point where, if the antitoxin is taken in the first twenty-four hours, the death-rate is only about one and a half per cent

A fight is going on against the gipsy moth, the hookworm, and other well-meaning inhabitants of the globe We suggest that bills be introduced by humanitarians into all the legislatures to protect these guiltless creatures Rats are unpopular just now because of the fact that they carry the bubonic plague and other diseases. There ought to be organized at once a society for the protection of rodents

The more reasonable these bills may be made to sound, the more chance there is that they may accomplish some unspeakably fatal blow against the human race. There are laws now in plenty forbidding cruelty. The great institutions which are specially aimed at by the cranks, like the Rockefeller Institute, are in the hands of men who are spending their lives in the cause of solid and real kindness Shall we take away from splendidly equipped experts of devoted character the right to judge what experiments are necessary, and put the question into the hands of some fool committee made up of persons in whom hysterical excitement takes the place of knowledge?—*Collier's*

SCIENTIFIC BOOKS

ELEMENTARY BIOLOGIES

BIOLOGY is unique among her sister sciences in the wealth of variation in the methods of presenting the subject to beginners It has been truly said that there are as many methods in this work as there are men conducting it. In the minds of many, this is as it should be, for there are requirements for one which are not for another The technical school emphasizes certain things which will not form a part of the course given in the classical college The material or *content* varies

It is a question in the writer's mind as to how much the *method* of presentation should vary in the several conditions The following well-marked methods of teaching beginning biology are recognizable (1) Biology as an integer, not resolved into its components, zoology and botany As subdivisions of this category, one finds (*a*) The type method, introduced into this country when Martin, in 1868, adapted Huxley's "Biology" to the students entering American colleges at that time The evolutionary chain was emphasized and morphology was predominant (*b*) The two-type method, which Sedgwick and Wilson used in their text, one animal and one plant being selected and studied exhaustively, others being presented as comparisons The functions of living matter were considered equally with the morphological features (*c*) A method, not especially new but well marked in the "General Biology" of Needham,[1] where the *principles* are emphasized, illustrations being selected towards that end and morphology reduced to a minimum, types as such are scarcely recognizable With the second great division (2), the science is resolved into its components, zoology and botany, but we may distinguish here, as before, well-marked subdivisions, (*a*) where the biological aspect is maintained and (*b*) where the work is presented as purely botany and purely zoology, with no reference to the common ground between them.

There have been published recently, in this country and abroad, several books whose purpose is to fill one of the fields given above Kirkaldy and Drummond[2] have followed 1*a* in giving a discussion of isolated types, with little intercommunicating cement. If biology is a science, as chemistry is a science and physics is a science, having definite content and definite principles, one would never de-

[1] Comstock Publishing Co, Ithaca, 1910

[2] "An Introduction to the Study of Biology," Oxford, 1909.

termine the *fact* from this English text There is left in the mind of the student a series of chapters from the story-book of living things, each complete in itself and bearing only remotely upon what precedes or follows The clever student will find the thread, but only he.

At the present time, no text has been written from the point of view of the Sedgwick-Wilson method, although there is in progress a book which will embody this idea, the types being somewhat different Therefore it can not be assumed that this method is being abandoned, as judged by the production of texts representative of it

The text of Professor Needham, referred to above, must be classed separately As we have already said, principles are considered in the light of selected examples, which are described in so far as the matter in hand demands If this point be borne in mind by the reader of the book, he will scarcely urge the criticism that the treatment is superficial The illustrations, many of which are original, are supplemented by photographs, and the quality of book-making is such that the figures, although inelaborate, are ample The absence of time-honored pictures is refreshing The attempt to bring into the book the results obtained in the laboratory of the investigator of the present is happily accomplished The work of the American school of cytologists and the experimental or analytical school in general is covered, briefly, it is admitted, but, in the mind of the reviewer, logically and sufficiently clearly to be appreciated by the student Much of the data of the volume concerns the insect world and this is readily understood when the principal interest of the author is considered It may be said that there is little material discussed in the book which is not readily placed in the hands of the students of any institution

The beautifully illustrated little book of Dr. Kraepelin[3] is moulded in a manner similar to the text of Needham. Professor Needham's book may be used as a laboratory guide and field companion, and in this respect it differs from all other texts mentioned here, with the possible exception of the one of Hegner It is a matter much to be regretted that the students of American institutions of learning, even after they have passed two or three years in the work, are unable to use books written in foreign languages There is no English volume which can approach this German book in wealth of text-figures, some of which are colored The text itself is well in keeping with the book-making, and in the experience of the writer the book as a whole is inspiring to the student who can master the written word, little as it may be The futility of presenting a book of the quality of Kraepelin's to English students is readily seen when one attempts to translate the book into English and put it upon the market at a German standard, still maintaining the selling price of the original (four Marks) Some cooperation may sometime be possible between the departments of Romance and Germanic languages and the scientific departments of our universities and colleges which may be beneficial to both.

McFarland's[4] book can scarcely be called a text, but rather a reader As such it will be useful, although the illustrations are poor throughout, many of no value whatsoever and the language is at least the limit of possibilities for the average student of beginning biology He will be found clamoring for Anglo-Saxon words when he opens the first chapter to read

> To study the problems of life apart from their cosmic relations is to lose much of their significance It is only by an appreciation of the endless changes—integrations and disintegrations—that pervade the universe that one comes to realise that those qualities by which we recognize living substance more or less closely correspond to the qualities of all substance and those forces by which it is animated to those forces by which the universe itself is controlled.

The medical side of the book is evident in the later chapters of the volume, such as

[3] "Einführung in die Biologie," Teubner, Leipzig, 1909. (Stechert)

[4] "Biology, General and Medical," Saunders, Philadelphia, 1910.

Blood Relations, Parasitism, Grafting, Senescence and Mutilation and Regeneration. When it is considered that more than nine tenths of the students taking the course in beginning biology go no farther in that department, we come to realize that our course should be so shaped that this great majority receive the consideration, and not the few who later become students in higher courses. It is for this reason, if for no other, that the economic side of the subject is warranted. Not that this be overdone. There is a danger that our references become so anthropocentric that we shall need another Galileo; man must be kept in his proper relation with the universe at large, and bacteria, moulds, pathogenic protozoa and antibodies must be seen to be part and parcel of this universe and not designed as helpers or scourges of mankind.

There is in this book a laxity in attention to details that will be discovered by the careful reader. Regeneration and continuous growth are two different things, although the author treats them as one. Mitosis precedes the appearance of the bud in the growing yeast and not *vice versa*. The granular theory of protoplasmic structure is *not* generally conceded. The figure of a typical cell, copied from Huber, is wretched and misleading. But it is easy to tear down and hard to construct. The book is inspiring to the student who looks broadly at the subject and one wishes it were more adapted to the needs of the modern American boy.

Hegner[8] has designed his text to occupy the first half year of a course where the second half year is devoted to vertebrate zoology. But it is not, *sensu strictu*, an invertebrate zoology. It falls in our category, 2*a*, being a biology with especial reference to invertebrates. The attempt is made to present the newer zoology to the beginner. Here we find the figures of Jennings, Yerkes, Morgan—in fact it may be called an American product from cover to cover. Consequently, the student finds himself at home at once among American forms and American names. It is not to be understood, however, that the view is circumscribed and that the data from foreign sources are eliminated.

[8] "An Introduction to the Study of Zoology," Macmillan, 1910.

Leaving aside for the present time the value of introducing the student directly to the unseen world of the protozoa, it may be said that the result is excellent in the light of the labor set before its author. The book-making is good, the illustrations are carefully selected and there is a unity in the volume which appeals very strongly to the reviewer. There are, as before, places where changes in future editions may be suggested. It is discouraging to the student to be introduced to pages of Greek and Latin terms at the outset. Sufficient unto the later pages is the evil thereof; let us not blunt his zeal at the start. The description of photosynthesis is so involved with that of respiration that the average student will not untangle them, and when the statement is made that "one group of processes (respiration) uses the waste products of the other (photosynthesis)" the error is obvious, for while this may be so for a part of the time, the relation does not exist at others (in darkness). As Professor Alexander Petrunkevitch has pointed out, the figure from Dahlgren and Kepner illustrating the alveolar hypothesis of protoplasmic structure is wrong, inasmuch as this theory involves a foam structure and not that of an emulsion. Amitosis should not be given the prominence that it enjoys in the book, whatever the personal views of the author, for the statements are not warranted by recent investigations. Moreover, the selection of Wheeler's drawings of amitosis in the follicles of the insect ovary to illustrate amitosis as a process of cell-*multiplication* is not fortunate, inasmuch as there is only *nuclear* and not cytoplasmic division. Maupas's schema of the effects of isolation from conjugation in *Paramecium* is given, although the text states, rightfully, that the work of Woodruff and others, such as Gregory and Jennings, has led to a different interpretation. Schultze's figures of the development of the sponge are adopted, although there is perhaps nowhere in biology a more difficult bit of

ontogeny to understand and to leave these figures without complete description is to give the student the impression that simple epiboly is involved These are but passing thoughts and are not in any way meant to detract from the value of the book

The question, however, remains, how many institutions could equip their students with the apparatus which is practically necessary for the carrying on of work along the lines laid down by Hegner? It will be remembered that the exact studies on the behavior of protozoa were made possible through the application of the Greenough binocular microscope in the hands of Jennings and others The time necessary for the development of technique for such experimental work had better be spent, in the mind of the present writer, in covering the subject of biology somewhat more broadly Again, there are not many students in the first year in the subject who could make much of a series of demonstrations of the development of *Cambarus* It may be that the present writer does not understand fully the *raison d'être* of the book and that the illustrations are not covered in the laboratory If this is true, why bring into the student's mind at all the intricacies of crustacean development? It does not involve any more completeness, for there are still many things left out of consideration, such as phylogeny Does embryology rightly form a part of the beginner's training? Above all, dogmatism is the *bête noire* of all teaching Is it not necessary to be dogmatic in teaching embryology in this course? Can the data be verified by the student?

It is the firm belief of the present writer that the division of the subject into its two grand divisions is a decided loss to the general student. Living things, after all, partake of the same general characters The more plants are studied in terms of animals, the better they have been understood The best zoologist is he who has had at the same time the best botanical training. If it be urged that there are few men who are capable of covering the two fields well, the answer may be made that it is so much the more deplorable. Specialization is carried too far even for the good of investigation if the zoologist can not think in terms of plants The great principles of the science have been formulated by studies upon both plants and animals A well-marked instance of this is the present-day work in genetics, in sex, in growth and the like If this is true, why not give the student the advantage of it?

It is the belief of the writer, too, that more than one year can very seldom be given by the general student to any one science Unless he be a prospective student of medicine, sanitation or biology itself, his major work must of necessity take him into other fields The deplorable ignorance of the average art student in things biological would be more quickly effaced if he were able to gain in one year a comprehensive course in this subject comparable to that he may receive in physics and in chemistry. To present the subject as zoology and botany defeats the end

The physicists and chemists have found time from their research to discuss teaching methods in their respective subjects, but the biologist—well, the biologist is made of finer stuff A symposium upon elementary biology at the American Association, resembling the discussions of the chemists and physicists which have been held in the past, would be most valuable to all who are concerned, directly or indirectly, in presenting the subject to the students of our universities and colleges

MAX W MORSE

TRINITY COLLEGE

Metabolism in Diabetes Mellitus By FRANCIS G BENEDICT and ELLIOT P JOSLIN Carnegie Institute of Washington 1910

The book contains 193 tables It has the detailed record of work on thirteen cases of diabetes, ten classed as severe and three as light Calorimetric measurements have been made, the carbon dioxide excretion and oxygen absorption recorded, urinary analyses accomplished, and the influence of food observed It represents the most ambitious attempt yet made in the study of human diabetes and is a

sincere endeavor to elucidate the problems connected with this disease

One of the most interesting features of this very extensive and laborious piece of work is the discovery of a constantly low respiratory quotient in patients suffering from severe diabetes, which accords with theoretical expectations

On page 211, the authors state that after giving beefsteak to a diabetic, "the excretion of sugar in the urine was not sufficient to indicate the excretion of a large part of the non-nitrogenous portions of the steak in the urine" But the sugar rose from 3 1 grams per hour to 8 6, an increase of 5 5 at the same time that the nitrogen elimination rose from 0 57 to 1 25, an increase of 0 68 grams per hour, which corresponds to increased protein destruction of 4 3 grams! According to this computation, 5 5 grams of dextrose might have arisen from 4 3 grams of protein which certainly does not support the negation quoted above

The reviewer is forced to disagree with the main contention of the book, that the heat production in severe diabetes is 15 per cent higher than the normal The error of Benedict and Joslin is twofold In the first place, their group of normal individuals, nine in number, include three weighing respectively 74, 80 and 83 kilograms These are not fairly comparable with diabetics weighing between 45 and 65 kilograms In the second place, the high metabolism obtained from a diabetic individual weighing 45 kilograms who was "extremely highstrung, nervous and apprehensive," and "not an ideal subject," plays quite a part in the average results upon the diabetic patients If the heavier, normal individuals be excluded, then six weighing between 48 and 67 kilograms produce 1 27 calories per kilogram per hour, and if the excitable diabetic be excluded, it is found that five individuals with severe diabetes and weighing between 49 and 65 kilograms, show an average heat production of 1 34 calories per kilogram, which is an increase of 5 per cent. above the normal, or about that obtained by other observers

Graham Lusk

SCIENTIFIC JOURNALS AND ARTICLES

The contents of *Terrestrial Magnetism and Atmospheric Electricity* for March, 1911, are as follows

"Two New Types of Magnetometers made by the Department of Terrestrial Magnetism of the Carnegie Institution of Washington," J A Fleming

"The Peculiar Magnetic Disturbances of December 28–31, 1908," R L Faris

"On a Variation in the Intensity of the Penetrating Radiation at the Earth's Surface Observed May 19 and 21, 1910," A Thompson

"Le Projet du Levé Magnétique de l'Empire Russe et les Travaux Magnetiques," M Rykatchew.

"The Physical Theory of the Earth's Magnetic and Electric Phenomena No III The External Electric Currents and the Earth's Magnetization," L A Bauer

"Magnetic Storms Recorded at the Cheltenham Magnetic Observatory, October 1 to December 31, 1910"

"Atmospheric Electricity Observations on the *Belgica* in 1907," H F Johnston

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SPECIAL ARTICLES

NOTE ON A CONGLOMERATE DIKE IN ARIZONA

While mapping the surface geology of Silverbell, Pima County, Ariz, in connection with a study of the ore deposits of that district, the writer found a conglomerate dike which seems to differ enough from the majority of clastic dikes previously described to justify a short note on its occurrence and probable origin

On a claim known as C M C No 4, about a mile north of the town, one of the many intermittent streams of the region has cut a gulch in a dark-colored quartz-porphyry In the bottom of this gulch and running parallel to it is a vertical fissure from six to eight inches in width filled with a hard compact mass of fragmental material. The fragments are generally angular and vary in size from grains of exceeding fineness to pieces of rock two inches or more in diameter. The greater part of the material is the quartz-porphyry that forms the walls, but a variety of other igneous rocks known to occur in the hills beyond the head of the gulch is also notice-

able. The depth of the fissure is unknown, but the drop in the stream bed showed a downward extent of six feet in which there was no perceptible decrease in width. The dike is parallel to the jointing in the porphyry and can be traced for over fifty feet before it pinches out. It is marked by a number of pinches and swells, giving the formation the appearance of several long, thin, connected lenses of conglomerate standing vertically in the porphyry.

The obvious explanation is that a fissure in the igneous rock has been filled by stream wash, afterwards cemented by calcareous waters, but the origin of the fissure is by no means as clear. Many of the clastic dikes hitherto described have been attributed to the squeezing up from below of fragmental material, while in those filled from above there usually has been evidence of considerable local disturbances to account for the formation of the open fissure.[1] For reasons that can not be given here, but which will be given in a forthcoming paper on the district, it is fairly well established that there has been at Silverbell no recent rock movement sufficient to form open cracks in any of the rocks. It seems more probable that the dike in question represents the result of a joint plane enlarged by weathering, and filled in part by the products of this weathering and in part by sediment washed in by the stream. It is therefore a local feature, and bears no relation to the dynamics of the district, although superficially resembling clastic dykes that have been the result of distinct orogenic movements.

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[1] J. F. Newsom, *Bull. Geol. Soc. Amer.*, Vol. 14, pp. 227–268, and M. R. Campbell, *Amer. Geol.*, Vol. 33, pp. 135–137.

NOTE REGARDING MAIZE FLOWERS

It may be well to make here the preliminary announcement of some results obtained in the continuation of my studies of the evolution of the "ear" of Indian corn (maize) begun some years ago. It will be recalled that I published in the *Popular Science Monthly* for January, 1906, a paper entitled "What is an Ear of Corn?" in which I homologized the "ear" with the central spike of the ordinary "tassel," of staminate spikelets. Continuing my studies I have now found perfect flowered (hermaphrodite) spikelets in well-developed "ears" occupying the usual lateral position upon the plants. These are fully figured in a paper which is nearly ready for publication under the title of "Perfect Flowers in Maize." It is found that these are produced upon plants that differ markedly from the ordinary type of Indian corn (maize). They are short-jointed, with broad, leathery leaves, and I venture the suggestion that those plants may resemble in some degree the original form from which our common maize was derived. One of the photographs shows the remnants of an abortive second flower in the pistillate spikelet near the well-developed kernel taken from one of these perfect-flowered ears, indicating that these spikelets were once two-flowered.

E. G. MONTGOMERY
THE UNIVERSITY OF NEBRASKA

THE INDIANA ACADEMY OF SCIENCE

THE twenty sixth annual meeting of the Indiana Academy of Science was held in Indianapolis, Friday, November 25, 1910. The president of the academy, Professor P. N. Evans, chose as his subject for his annual address, "The Place of Research in the Undergraduate Schools." Forty-two regular papers were presented. Those of most general interest were as follows:

"Plants and Man—Weeds and Disease," Robert Hessler, of Logansport.

"Indiana Municipal Water Supplies," Charles Brossman, Indianapolis.

"Subterranean Drainage in the Bloomington Quadrangle," J. W. Beede, of Bloomington.

"Conservation Problems," Frederick J. Breeze, of Lafayette.

"The Properties and Reactions of Thrombin," L. J. Rettger, of Terre Haute.

"The Nature and Origin of the Fish Fauna of the Plateau of British Guiana," C. H. Eigenmann, of Bloomington.

"A Physiographic Survey of the Terre Haute Area," Charles R. Dryer, of Terre Haute.

"Paleolithic, Neolithic, Copper and Iron Ages

in Shelby County," F. W. Gottlieb, of Morristown.

"The Temperature Coefficient of the Surface Tension of Water," Arthur L. Foley, of Bloomington.

"Gaseous Fermentation in Sweetened Condensed Milk," O. F. Hunziker, of West Lafayette.

"Weed Problem in Indiana," Stanley Coulter, of Lafayette.

"The Water Balance of Desert Plants," D. T. MacDougal, of Tucson, Arizona.

"Indiana Fungi," J. M. Van Hook, of Bloomington.

"An Ecological Survey of the Lower Whitewater Gorge," M. S. Markle, of Richmond, and L. C. Petry.

"Timothy Rusts," A. G. Johnson, of Lafayette.

In the evening Dr. D. T. MacDougal, of the Desert Laboratory, at Tucson, Arizona, gave a very interesting and instructive illustrated lecture on "Desert Days and Desert Ways."

Professor Charles R. Dryer, of Terre Haute, was elected president of the academy and A. J. Bigney, of Moores Hill, secretary.

A. J. Bigney,
Secretary

SOCIETIES AND ACADEMIES

THE WASHINGTON ACADEMY OF SCIENCES

The 67th meeting of the Washington Academy of Sciences was held, under the direction of the president, Dr. F. W. Clarke, at the Cosmos Club on the evening of January 19, 1911.

Dr. F. M. Jaeger, professor of inorganic and physical chemistry in the University of Groningen, Holland, gave an address on "Anisotropic Liquids and so called Fluid Crystals."

Numerous experimental researches have established the fact that in certain liquids, and under certain conditions, there are forces that act upon the molecules differently in different directions. Hence the conception of the liquid state as one characterized by irregular molecular motion is no longer tenable—a fact that fills the subject with interest and has led to many an ardent discussion.

Dr. Jaeger pointed out the similarity of solid crystals with easy gliding planes, to liquid ones, and the analogy of their changes to those of polymorphic substances. He also described their phase transitions and in particular showed the properties of substances that melt successively to three or more stable liquid states.

By means of projections he showed such properties of liquid crystals as their form, dichroism and strong birefringence, and made clear his argument that the emulsion theories advanced by some to explain the observed phenomena, are only based upon the misunderstood turbidity due to birefringent liquid phases. He also illustrated the strange phenomena of "enforced" and "spontaneous" pseudo-isotropy, and showed the axial images of clear, uniaxial liquids and their strong rotating power.

Proceeding to the real anisotropic liquids, which he illustrated by the different properties of p-azoxypenetol, he discussed the principal differences between the spheres of such liquids and real crystals, their heat motion and their diffraction phenomena when mixed with other substances, and concluded with an elucidation of their magnetic induction.

The formal presentation of the paper and its discussion were followed, after adjournment, by experimental demonstrations to many of the more interested of the audience.

The 68th meeting of the Washington Academy of Sciences was held at the Cosmos Club on the evening of February 1, 1911, with President F. W. Clarke in the chair.

Dr. W. D. Bancroft, professor of physical chemistry in Cornell University, gave his lecture entitled "A Universal Law."[1]

The many chemists of the audience roundly applauded the claim that all branches of human knowledge are but portions of chemistry—mostly subordinate. They seemed highly to approve the idea of spelling "alchemy" with a double "l," and indeed the speaker's familiarity with things not generally called chemical went far to justify this notion.

The illustrations of the universal law were drawn mainly from that branch of chemistry commonly called biology, and those who still persist in calling themselves biologists instead of chemists accepted in good grace many a humorous and telling side remark.

When the lecture was over and the time for talking back came it seemed that most every one had something to say; but whether biologist or some other sort of chemist, each declared the meeting a great success, and since then has done much to make the "universal law" the universal topic.

W. J. Humphreys,
Recording Secretary

[1] See Science, February 3, 1911.

SCIENCE

FRIDAY, MARCH 24, 1911

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THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

THE CONTROVERSY BETWEEN MATERIALISM AND VITALISM CAN IT BE ENDED?[1]

IN order that this discussion may be profitable, it must rest on an unequivocal meaning of some sort for the words "materialism" and "vitalism" It will, of course, be impossible to give definitions that will be altogether satisfactory to everybody, perhaps to anybody, even the writer. Every one may, however, be counted on to accept some definition *as a basis of the discussion*, if he thinks the question raised is worth discussing at all

Since my main desire is in behalf of clear thinking and remunerative work in biology to-day, my effort at defining the terms will specially regard present tendencies and methods in our science rather than lexicographical authority and historical usage, though the historical aspect must not be wholly ignored

By materialism I shall mean the belief that all biological phenomena may be completely explained by referring them to the material elements of which organisms are composed The term "mechanism" as used to-day, not in practical zoology, but in philosophical biology is, I think, exactly synonymous with materialism At any rate, I shall consider such to be the case.

It is less easy to formulate a definition of vitalism. 'I understand the term to mean the belief that organic phenomena can not be fully explained by referring them to the material elements of which organisms are composed, but that some-

[1] Address of the vice-president and chairman of Section F—Zoology.

thing not really belonging to the natural order, either explicit or implicit, is present in living things. The essence of the conception, whatever be its variety or form of statement, is that something absolutely new and novel came into the world when living beings came, and that this came as a special force, or principle, or factor—anything you have a mind to call it, so long as it is *not* material. A further essential to the conception is that this new thing is elemental, protean, once-for-all. It is not exactly the life itself of the organism. It is rather the informing, underpinning, ultimate motor, of life.

So far as a general discussion like this is concerned, there is no advantage in taking cognizance of a neo- or rejuvenated vitalism, beyond noting that the efforts in conformity with the modern demand for rigorous analysis is to limit, or locate this extra somewhat more definitely in, or among, the material substrata of organisms.

So much for definitions. I said a moment ago that the historical aspect of the subject must not be wholly ignored. All, however, that seems incumbent upon us in this quarter is to remind ourselves that the term materialism has cut a considerable figure in the philosophies of the schools, while the term "vitalism" has not. Further, to most traditional and vocational philosophers materialism as defined is a very naive, almost childish conception: while its adversary, vitalism, has little or no standing among philosophers. Its essential interests are abundantly cared for by professionals under other captions. The significant thing for us in this treatment of materialism and vitalism by philosophy is the evidence it affords that neither materialism nor vitalism stand up well as philosophical conceptions, under the fire of rigorous logical analysis and a highly developed dialectic. This circumstance can not go unheeded by any careful biologist, for whatever may be his estimate of the worth of metaphysical systems, he can not fail to recognize that every trained metaphysician carries a blade of analysis, and of offense and defense in intellectual encounter, that may well elicit the admiration and be the dismay of any ordinary man of science.

Now this slighting by formal philosophy of conceptions that biology makes much of when it attempts to be philosophic, ought to cause biologists to wonder if perchance their philosophizing is less happy, less trustworthy, than their achievements in science proper. This leads to where I may give my categorical answer to the question taken as the subject of the paper: The controversy between materialism and vitalism would end forthwith could both conceptions be recognized as only mile-stones along the road of progress, could they both be seen to contain truly living substance encapsuled by dead matter which must be left behind as crumpled exuviæ when the next stage of advance is entered upon. The controversy will not cease but will continue with increasing unfruitfulness so long as either side holds the truth it sees as absolute and all-sufficing.

To bring the real inwardness of the case home with force I am going to state it in a way that will at first seem extreme and harsh. ***Materialism is a lineal descendant in rational process of the basis of magic of certain ancestors of ours*** who, though far cruder than we are, were no less earnest of desire and of effort to understand nature and get on well with her. ***Vitalism is similarly descended from the animism of still other ancestors***, probably somewhat more recent and less crude, but no less earnest and sturdy than those with whom magic reigned.

This theory of the origin of materialism

and vitalism will probably appear not only harsh but ridiculous at first sight. The idea, it will be said, that many of the very foremost biologists of this hour are kindred, doctrinally, to magicians and occultists, is too absurd to merit consideration. To those who would dispose of the idea in this summary fashion because of a certain sense of injustice or of hurt pride, I would earnestly put the question, Are we truly evolutionists or are we not?

I am convinced that many of us, even biologists, who have never hesitated to accept evolution, do not see and feel its mighty importance when it comes to human traits that are particular and personal. Biologists more perhaps than other class need the regenerating touch of Bergson's "L'Evolution Créatrice." We need to recognize as we never have that evolution means indeed something new coming on every moment, and that since the new grows out of the old it can be neither wholly different from nor wholly alike that from which it came. We need further to see the vital meaning of the extreme probability in the light of myriad facts now constituting our biological knowledge that evolution is truly a universal principle, that is, that there is not a trait, physical or spiritual, of ours, that is wholly finished off and at a standstill. We are every one of us in every atom of our existence and at every instant on the move to some extent, up or down, forward or backward.

Where did all our science—not merely as to its formulation but as to its physical and psychical substratum, come from? Only a few thousand years ago our race not only did not possess a great body of knowledge of the world, but it was not scientific, as we now understand the term, either in mode of observing and thinking or in desire. Did our talent for science come to us as a gift from heaven, or has it grown by slow degrees from hundreds of impulses and influences spread over thousands upon thousands of years and over many lands and seas?

The theoretical answer to the question is on the lips of every one in an audience like this. Our talents came by the way of gradual growth, of evolution. Practically, though, we treat our knowledge much as did our forebears who believed their gifts came direct from heaven. Alongside this question let us ask another. What has become of all the mysticism, the fetishism, the magic, the animism, the divination, and the rest, so characteristic of every race and class of men outside of civilization? Is it reasonable, in the light of what we know about the course and laws of evolution to suppose that those psychical or other qualities that made our ancestors for generation after generation mystics should have left no trace in peoples under civilization excepting in the comparatively few professional mediums, clairvoyants and persons noted for their ignorance and superstition? Could we reasonably expect any modern whatever to be wholly cut off from any trait that was universal and of simply tremendous import in all his early ancestors?

I insist that there is a mighty vein of what makes mystics in the nature of every normal man and woman no matter how elevated a level of culture, or intellectual development he has reached. I insist further that we have not the slightest ground in facts at our command for supposing this element in man's nature can be eradicated and leave him civilized. The truth is that just so far as man feels or has sentiment, imagination, fancy, at all, by just so much is he mystically inclined. It is his intellect, his reason, alone that saves him from being a mystic indeed; and just as sure as any element of pure fancifulness gets into the essentials of a scientific, that is gen-

uinely rational, doctrine, that doctrine departs at once from the way of science and journeys on the way of mysticism and occultism.

This means, brought down to specific application, that search to-day after the "germ of life" in the sense in which this phrase has leaked out of biological laboratories and got into the popular mind is mystical no less certainly than was search after the philosopher's stone. It means that a certain heavily veiled hope being held out in certain biological quarters of the indefinite prolongation of life is the old search after the elixir of life and the fountain of perpetual youth, refined and modernized. It means that those biologists who by intense research on, and still intenser speculation about, a comparatively few "elements" and "substances" in the less well-known sections of the organic realm, seem to expect presently to find a hidden key that will unlock all or nearly all the mysteries of organic nature, are on the same quest with Dr. Faustus, the quest after ultimate knowledge and are doomed to failure and disappointment.

In other words, *the mighty tendency of the human mind to transcendental and mystical interpretations of the world which manifests itself among primitive peoples as fetishism, animism and magic, among more advanced peoples as idolatry proper, and among nearly all of the most advanced peoples as the supernatural element in religion, persists in our physical science, particularly in our biology, as materialism and vitalism.*

Stating the problem in this broadly generalized way commits us to a very large, difficult and important thesis. Obviously, to deal with more than a small fragment of it here is out of the question. In baldest essentials the truth can be stated thus: Materialism in common with magic consists (*a*) *in assuming the existence of material bodies to explain certain observed phenomena when such bodies do not in reality exist, or at least the existence of which is never proved observationally*, or (*b*) *in assuming that certain observed bodies possess qualities which explain phenomena when in reality no such qualities are possessed by the bodies, or at least are never observed directly*. Vitalism in common with animism consists *in assuming the existence of non-material, essentially extra-corporeal forces or principles to explain phenomena when such forces or principles are never proved to exist*. The sophisticated thinker and the untutored savage are alike in recognizing the mystery inherent in the universe, and they are further alike in their attempted explanations.

Just the fact that the universe is perpetually in the throes of "Creative Evolution" makes this mystery all-pervasive and unending. It is of the very essence of a living world. The wise man takes due account of this element of the incalculable, the unpredictable as a characteristic of the universe, particularly of animate nature, he is not driven thereby to despair of ever knowing anything, but on the other hand is preserved from the obsession of finding a "sufficient cause" for everything under the sun. He recognizes that the whole process is the one great, sufficient and final cause of all its phases, and with that conviction puts an end to all futile search for "complete explanations" and "absolute causes." The proximal causes, the workings of the great process, are, however, of absorbing interest to him. And they are of interest down to the smallest detail; nothing is insignificant, negligible, just because every minutest fragment is an integral and therefore influential part of the whole.

From this point of view, it can be readily

seen how futile is the attempt of materialism to find the "cause" of life in any one set of material elements, and how equally futile is the attempt of vitalism to find the significance of the whole in some intangible "force" Both fail to see that any set of processes taken as a whole and in its organic relation to the rest of the universe is its own final and only adequate explanation Each attributes to natural objects qualities which no single object or set of objects possesses—qualities which afford a complete "explanation" of another object Both attempt to explain everything in terms of "something else," and this in essence amounts to a denial of the reality of the organic beings which we actually see and deal with

WM E RITTER

LA JOLLA, CAL

INVESTIGATIONS OF THE CARNEGIE INSTITUTION[1]

WORK in the ten specially organized departments of research in the institution has gone forward during the year with increasing vigor and with increasing productivity All of these novel establishments may be said to have now passed the preliminary stages of organization, equipment and tentative experience, so that henceforth their efforts and resources may be still more effectively directed and applied Most of the departments have been strengthened during the year by additions to the staffs of investigators and by accessions to equipment and other facilities, some of which latter have come through the generosity of friends, who have thus shown their appreciation of departmental researches

But while the existing status of departmental affairs is in general highly satisfactory, it appears essential to again call attention to the fact that with present income and current economic conditions no further expansion of departmental appropriations can be expected It may be necessary, on the contrary, to curtail research in the departments in order to keep the aggregate expense of the institution within income It need not follow, however, that this prospective diminution in financial outlay will cause a corresponding diminution of productivity, for work of investigation, like work along other novel lines, is usually most costly in the preliminary stages

Referring to the current "Year Book" for interesting and instructive details in the reports of the directors of departments, some of the salient features of their activities are summarized in the following paragraphs

It is a maximum in the pursuit of physical science to proceed from the simpler to the more complex in any attempt to discover the relation among observed facts. In accordance with this maxim, the headquarters of the Department of Botanical Research are located in a desert area where the facts of plant life are exhibited, in general, in their simplest, though often extreme and highly specialized, relations. But even under these favorable conditions plant life presents problems whose solution requires aid from many sciences other than those which are commonly held to make up biology, and especially from chemistry, physics and meteorology Thus the researches of this department call for much collaboration and for a wide range of observation, experiment and determinate analysis

During the year the director of the department has continued his investigations on the water-balance of succulent plants, on the conditions of vegetable parasitism, on the variability in plant species induced

[1] From the report of the president

by chemical treatment of their seeds, and on the influences of climate on plant organisms. In collaboration with Professor Ellsworth Huntington, research associate of the department during a portion of the year, the director has begun a general climatological study of the region about Tucson, giving special attention to the factors and effects of the Santa Cruz and Asuncion river systems.

Dr. Cannon, of the permanent departmental staff, has given attention especially to his elaborate investigation of the root systems and habits of desert plants. For the purpose of extending the range of his studies in this fundamental subject he visited the Sahara Desert and will spend most of the year in that advantageous field for both comparative and direct observations. Some of the more important conclusions already established in respect to this inquiry are set forth in the director's current report.

Dr. Shreve, also of the permanent staff of the department, while occupied with the more general problem of the relation of plants to climate in the United States, has also carried on special investigations of the vital statistics of plants in the vicinity of the Desert Laboratory, of the vegetation in the Santa Catalina Mountains, and of the physiological characteristics of the lace-fern family of plants. In the first of these researches he has been aided by the collaboration of Dr. Livingston, who resigned from the staff of the department a year ago to accept a professorship in Johns Hopkins University.

Observations on the phenomena presented in the drying up of Salton Sea, and especially on the influx of vegetation over the bared strands and islands of this slowly retreating body of water, have been continued during the year. In this work a series of soil analyses of the strands has been secured through the cooperation of Mr. E. E. Free, of the Bureau of Soils of the U. S. Department of Agriculture.

Publications by members of the department issued during the year are shown in the list on pages 32-33 and in the bibliography of the "Year Book." Others in press are Nos. 131, 139, 141. One of these, No. 139, on the guayule, a desert rubber-producing plant of considerable economic importance, is the work of Professor Francis E. Lloyd, formerly a resident associate of the department, but now a member of the faculty of Alabama Polytechnic Institute.

So many converging lines of fruitful research are now being pursued by this department that it is difficult to summarize fitly its current progress. This duty must be accorded, in fact, as in all other cases, to the director of the department concerned, in his annual reports and in his more detailed publications. From the abstract scientific point of view the most interesting feature of this work is found in the introduction of statistical and other quantitative methods, whereby biology is now passing from the first to the next higher stage in the development of a science. From the more popular points of view the work in question is of special interest by reason of its bearing on the economics of plant and animal breeding and by reason of the light it is certain to shed on the laws of human heredity.

So large and so intricate a field of work calls for varied objects and subjects of experimentation and for the resources of many collateral sciences. Thus, studies of heredity have developed the necessity of certain investigations in physiological chemistry, and a small equipment for this purpose has been fitted up in a room of the main laboratory building and put in charge of Dr. R. A. Gortner. Similarly, for

studies of the changes which organisms undergo in dark caves and in deep waters, an artificial cave has been added to the basement of the laboratory, and the work of experimentation by means of this adjunct has been assigned to Dr A M Banta, whose early investigations in this line were printed by the institution some years ago in Publication No 67

In order to meet the increasing needs of the department for land for the cultivation of plants and the breeding of animals, the institution purchased in January, 1910, a tract of 21 acres of very desirable land lying about a mile east of the laboratory It may be noted also that Goose Island, in Long Island Sound, acquired for the department a year ago, has already been put to good use in experiments on plants and animals in a state of isolation

It is a source of pleasure to record that two friends of the department have shown their appreciation of the director's enterprise by gifts which will greatly aid him in the prosecution of his work one has supplied a wharf and a shelter house on Goose Island, the other has furnished funds essential to establish, near to but independently of the laboratory, an office for the collection and interpretation, under the direction of Dr Davenport, of data bearing on human heredity

The principal steps which have been necessary and in large degree preliminary in the development of the work of the geophysical laboratory are recounted with instructive particularity by the director in his report for the current year They are the steps required to pass from a merely descriptive knowledge of rock formation to a knowledge based on definite measurements. Briefly stated, these steps are four in number, namely: provision for correct temperature determinations over the entire range involved in the processes of rock formation, provision for like determinations of the chemical reactions of these processes, provision for precise microscopic, optical and crystallographic measurements, and provision for the quantitative applications of high pressures to rock masses and rock constituents

In supplying the desiderata just indicated for its own special work, the laboratory has already achieved results of prime importance also to many other fields of physical and chemical science Thus, two contributions of great import to general physics and chemistry have been brought out during the past year The first of these is a determinate extension of the scale of temperature measures from about 300° C to about 1,600° C This is a fitting supplement to the classic work on thermometry begun more than thirty years ago under the auspices of the International Bureau of Weights and Measures It must take rank, in fact, with the fundamental advances in the technique of thermometry The other contribution is a determination of the system of compounds which may arise in combinations of the three most important oxides entering into the composition of rocks, namely, silica, lime and alumina This system is of special economic interest, since it includes, among many other compounds, the hitherto much studied but baffling Portland cement The complexity of the investigations required to analyze this system is indicated by the facts that it involves the interaction of fourteen minerals and the formation of sixteen ternary eutectics, or substances whose melting-points are lower than those of the primary constituents

Many other important investigations are outlined in the director's report and the productivity of the laboratory may be inferred from his citation and review of twenty-five publications emanating from

the staff during the year It is of interest to note in this connection that researches from the laboratory find ready access for prompt publication through current journals both at home and abroad Many of these papers have already been published in German as well as in English and arrangements have been made during the year to maintain this doubly effective mode of publication

Six years ago, when the duties of the presidency were assumed by the writer, he deemed it desirable to visit at the earliest opportunity all individuals pursuing researches under the auspices of the institution It soon developed, however, that a speedy accomplishment of this task would prove quite impracticable, and it became essential to adopt a much more restricted program of activities in this direction Thus, while nearly all other departmental establishments of the institution have been visited by the president prior to the past year, his first visit to the Tortugas Laboratory was not made until June, 1910 Having already entertained very favorable, but somewhat indefinite, opinions concerning the wisdom of the choice of this locality for a marine laboratory, it is fitting to state that the extraordinary biological resources and the salubrity of the summer climate of the Tortugas group are so evident as to rouse the enthusiasm of any interested observer As pointed out by the director of the laboratory, the isolation even of these islands furnishes important advantages to the investigator In brief, the favorable impressions gained during the first visit in respect to the locality and in respect to the scientific spirit and possibilities of the establishment are only tempered by the present incapacity of the institution to give more liberal financial support to this department of work

Two emergencies seriously affecting the department and calling for prompt action have arisen during the year One is due partly to the gradual abandonment by the United States navy of the supply depot and wireless station at Tortugas, thus rendering communication between Key West and the laboratory less certain and frequent than hitherto The curtailment of this source of aid generously extended by the navy to the laboratory during the past six years has forced upon the department the necessity of providing better independent transportation than that afforded by its best boat, the *Physalia* One object, therefore, of the visit above referred to was to consider with the director the best way to meet this urgent need Accordingly plans and specifications for a 70-foot twin-screw boat were prepared during the summer, and on authorization by the executive committee, at its meeting of October 18, 1910, a contract for the construction of this proposed vessel was let October 31, 1910, to the Miami Yacht and Machine Co, of Miami, Fla, with the expectation that the contract will be completed July next

The other emergency arises from the damage to the laboratory caused by the hurricane of October 14–18, 1910 The extent of this damage is not definitely known at the present writing, but steps have been taken to get trustworthy details at the earliest practicable date, so that estimates of the expense required to restore the building may be ready for submission to the board of trustees before their next meeting in December

It is gratifying to note that the opportunities afforded for intensive research by the laboratory are so highly appreciated that applications for its privileges are already more numerous than can be granted. Each year since its establishment additions have been made to its equipment and the

director hopes that with some minor additions quarters may be found for fifteen or more investigators every summer During the past season twelve associates, one collector and one artist illustrator, in addition to the director, carried on work at the laboratory Of the investigators, nine returned to continue work begun in previous years, while two of the other three expect to return in 1911 Many researches are in progress, therefore, as may be seen by reference to the full reports of the director and his associates in the current "Year Book"

Of the publications of the department during the year, special attention should be called to the comprehensive monograph in three quarto volumes by Dr Mayer, on "The Medusæ of the World," issued as Publication No 109 of the institution Two other volumes, Publications Nos 132 and 133, containing short papers from the director and associates of the laboratory, are now passing through the press

Capital progress has been made during the year in the large and exacting undertaking which this department has so successfully started Work at the observatory in Argentina has gone forward at an unprecedented rate and with such a degree of thoroughness and completeness as to give assurances that this part of the enterprise will be completed within the next year Great credit is properly assigned by the director to the zeal and the industry shown by the resident staff of the observatory in thus completing, within so short a time and without lowering the highest standards of precision, an unparalleled amount of observational work The general success of this enterprise affords a forcible illustration of the superior effectiveness of a department of research which may proceed with its work intensively in accordance with carefully prearranged plans and organization of effort

While the supplementary observations of the positions of the stars are going forward in the southern hemisphere, arrangements for the final computations of these positions are proceeding at the Dudley Observatory, for the formidable task of observation must be followed by a still more formidable task of computation Preliminary to the grand catalogue of stellar positions projected by the department, there has been issued by the institution during the past year, as Publication No 115, a catalogue of 6,188 stars for the epoch 1900 This has already assumed first rank among catalogues of precision and the demand for it indicates that a second edition may be called for before the larger catalogue is completed In response to a demand from other astronomers and in view of the needs of his own work, the director has published also, through the Dudley Observatory, a "List of 1059 standard stars for 1910"

Although this laboratory has been occupied less than two years and is not yet fully equipped, it has already produced contributions of fundamental importance to our knowledge of the chemistry, physics, physiology and pathology of nutrition Its experience, like that of all the laboratories of the institution, affords an impressive demonstration of the productivity attainable by concentrated effort along determinate lines of research Construction and installation of additional equipment, the prosecution of investigations, and the publication of results have gone forward simultaneously during the year.

One new calorimeter has been completed, another partly constructed, and various auxiliary apparatus for use with these and the earlier equipments have been supplied Similarly, respiration apparatus for men,

respiration apparatus for dogs, and many improvements in the calorimeter section of the laboratory have been made. Several pieces of apparatus have been acquired also by purchase abroad, and the efficiency of the machine shop has been improved by the addition of a precision lathe.

The investigations under way at the laboratory and outlined in the director's report are too numerous and too technical to permit further abstract or paraphrase. It may suffice here, therefore, to cite one of the most important of these investigations in which decided progress has already been made, but which may yet require many years to complete, namely, the nature and meaning of metabolism in diabetes. In the researches on this recondite problem the director has thus far had the good fortune to enlist the active cooperation of Dr. Elliott P. Joslin, through whose aid especially it has been possible to use the laboratory's apparatus in detailed observations and measurements of a number of diabetic patients during the past two years.

The preliminary results of the research just referred to were regarded as so important as to justify prompt public announcement, and they have accordingly been printed during the year in Publication No. 136. Interest in the laboratory and its work is now so widespread that another volume, describing in detail the respiration calorimeters and their applications, by the director and Mr. Thorne M. Carpenter, has been issued as Publication No. 123. Many shorter publications from members of the research staff have appeared during the year in current journals and in the proceedings of learned societies.

The rapid growth in equipment and facilities and the equally rapid progress in the production of capital results from the researches at this observatory are at once sources of surprise and gratification to the astronomical world. Work during the past year has gone on with little diminution of vigor, although illness of the director has forced him to relinquish his activities for a considerable portion of the time. He has recently gone abroad for a season and the departmental report for the past year has been prepared by Mr. Walter S. Adams, now acting director of the observatory.

The work of this establishment is now so extensive and so varied that it is somewhat difficult to summarize even in its salient aspects. In addition to the observatory proper, with its four principal telescopes and much auxiliary equipment on Mount Wilson, there are the physical laboratory and the instrument shops at Pasadena, along with special divisions devoted to the work of computations and construction respectively. To become conversant, therefore, with the complexity of activities of this department, one must read the somewhat lengthy but relatively condensed annual reports of the director.

By way of equipment several large pieces of apparatus for the new tower telescope, for the 60-inch telescope, and for the 100-inch grinding machine have been made at the shops. The towers for the new 150-foot tower telescope, begun a year ago, are now finished along with the well, 75 feet deep in the rock below, which forms a part of the telescope tube of this novel instrument, now essentially complete except for its spectroscopic attachments still under construction at the shops. Some preliminary trials made recently with this instrument indicate that it will fulfill the sanguine expectations entertained in respect to its capacity.

At the time of the annual meeting of the board of trustees a year ago "The Monastery," a wooden building on Mount Wilson supplying quarters for the resident members of the observatory staff, was com-

pletely destroyed, along with a considerable number of books and other valuable property, by fire This building has been replaced during the year in somewhat enlarged form by a reinforced concrete structure

Progress has been made during the year in the details of designs for the proposed 100-inch or "Hooker" telescope, for which Mr J D Hooker, of Los Angeles, made a substantial gift to the observatory some years ago This work has been in charge of Professor Ritchey, whose construction of the 60-inch reflector has proved so signally successful After repeated trials and failures to make a satisfactory disk the contracting firm at St Gobain, France, have quite recently renewed the hope that a disk they now have annealing may meet the exacting requirements set by the astronomers

Allusion has already been made in an earlier part of this report to the meeting of the International Union for Cooperation in Solar Research held at the observatory during the week of August 29 to September 4 of the current year An outline of the proceedings of this meeting, which was of peculiar interest to the observatory staff, is given by the acting director at the end of his report In spite of the difficulties of access to the observatory site, this meeting was regarded as the most important held by the union Opportunities were afforded the visiting astronomers and physicists to inspect the entire establishment and to test especially the efficiency of the telescopic apparatus Their appreciation of these opportunities and of the optical perfection of the telescopes, particularly of the 60-inch equatorial reflector, is a source of keen encouragement to the observatory staff

Attention is invited to the interesting account given in the departmental report of the numerous investigations now under way at the observatory and in the physical laboratory at Pasadena They are so effectively summarized in this report that any restatement appears superfluous

No department of research in the institution is conducting work which is at once so obviously practical and so obviously theoretical as the work of the department of terrestrial magnetism Every one acquainted with the daily use of the compass in exploration, in surveying, and in navigation recognizes the practical utility of a magnetic survey of the earth But those who recognize that any utilitarian results may come from a deeper knowledge of the earth's magnetism and its cosmic connections are at present very limited in number Nevertheless, the history of science warrants a confident expectation that the latter results will ultimately prove to be of much greater value than the former

The more striking events of the year in this department refer naturally to the non-magnetic ship *Carnegie*, which was off on her first cruise at the close of the previous fiscal year She was then at Falmouth, England, where her determinations of the magnetic elements were compared with independent determinations made at the permanent magnetic observatory of that port She proceeded thence, November 9, 1909, to Funchal, Madeira, thence to Hamilton, Bermuda, and thence, under tempestuous conditions which proved her seaworthiness, to Brooklyn, N. Y, where she arrived February 17, 1910 Here she had her copper sheathing applied by the constructors, as required by their contract, and was overhauled and refitted for a three years' circumnavigation cruise It is a pleasant duty to report that in all essential respects this vessel has proved more effective than was anticipated It has been demonstrated that even in rough weather

the three magnetic elements (declination, dip and intensity) may be determined with a precision little short of that attainable in a fixed observatory Thus she was able to discover on her first cruise errors of unexpected magnitude in the best sailing charts of the north Atlantic, and she is certain to attain at least an equal degree of precision in all future ocean work By crossings of her own tracks and by connections at all available ports having magnetic observatories it will be practicable to exclude the possibilities of any important errors in this work

Similarly satisfactory progress has been made also in the land work of the department during the year The expedition in Africa, from the Cape to Cairo, undertaken by Dr Beattie and Professor Morrison as temporary associates, was completed early in the year, a total of 348 stations having been occupied Mr Pearson, field observer of the department, continued work in Turkey in the early part of the year until relieved by Mr Sligh, who extended the work to Palestine, Syria, Arabia, Mesopotamia and the islands of Rhodes and Cyprus Up to the end of July of this year these two observers had occupied a total of 47 stations Another observer, Mr Stewart, left Washington early in June to begin extensive work in South America, proceeding in the launch *El Imán*, provided especially for work along the Amazon and its tributaries Additional observations are reported also from Canada and from various European countries in which initial determinations or instrumental comparisons have been made

The office work of the department has gone forward with corresponding productivity, the large volume of computations required being kept closely up-to-date The preparation for collective publication of data obtained by the department on land and on sea is now well advanced, although many of these data have been already furnished for use by hydrographic offices and other national and international bureaus Much critical attention must be devoted by the office staff to the inspection and perfection of instruments and auxiliary appliances By the aid of a skilled mechanician and a shop now attached to the department it has been practicable to attain a degree of instrumental perfection and a degree of economy in cost not hitherto equalled in this kind of work

About fifty research associates have carried on investigations under the auspices of the institution during the past year, either by aid of grants made directly to the individuals concerned, or by aid of grants made to organizations like the American Schools at Athens and Rome, or by cooperation with our departments of research In general, each of these associates has been in collaboration with one or more colleagues or assistants, so that the total of those contributing to this work has been upwards of one hundred investigators The range of their investigations embraces sixteen distinct fields of research, namely archeology, astronomy, botany, chemistry, geology, geophysics, literature, mathematics, metallurgy, meteorology, paleontology, philology, physiology, political science, terrestrial magnetism and zoology Reference must be made, therefore, to the reports of individual investigators and to the general bibliography, to be found in the current "Year Book," for a fuller account of the fruitful activities in this branch of the institution's work It should be observed, however, that existing and prospective economic conditions, elsewhere referred to in this report, will probably require curtailment in this branch of work in the near future.

CHARLES HUGH SHAW

THE subject of this sketch was born near Delaware, Ohio, July 14, 1875 He was educated in the public schools of Delaware County and city and in Ohio Wesleyan University located hard by He received the degree of Ph D from the University of Pennsylvania in June, 1900, at the age of twenty-five

Shaw very early exhibited a strong leaning to the natural sciences and while still in the public school he became thoroughly acquainted with the local flora In college under the direction of Dr E G Conklin, at that time professor of biology in Ohio Wesleyan, he was appointed an assistant charged with the collection and preservation of a complete herbarium of that flora Under the inspiration of the same instructor he mastered the elements of zoology, and became saturated with the principles of organic evolution When Dr Conklin was called to Northwestern University his successor was a botanist and Shaw was employed to continue the instruction in zoology, which he did for two years with great credit to himself

Immediately after his graduation in 1897, he took up the advanced study of botany at Pennsylvania under Professor J M Macfarlane, whom he had met the previous summer at Woods Hole While carrying on his graduate studies and for several years thereafter he gave instruction in biology at Temple College The year he received his doctorate he accepted a place also in the faculty of the Medico-Chirurgical College of Philadelphia Here he was promoted through the various ranks and became full professor of botany in 1907 Resigning his place in Temple College in 1903, he became professor of biology at Ursinus College near Philadelphia, and continued to hold the two positions, that at the Medical College and at Ursinus, for four years Upon attaining full rank at the Medical College he gave up the work at Ursinus, and just a few months before his death he resigned at the Medico-Chirurgical to accept an assistant professorship in plant physiology at the University of Pennsylvania

Dr Shaw was a field botanist of the first rank He had collected and studied plants over many parts of the virgin land of the United States, Canada and Europe The summer of 1899 he spent with Goebel in Munich and the summer of 1906 with Flahaut in Marseilles The summers of 1904, '05, '07, '08, '09 and '10 he conducted botanical excursions to the Selkirks and Canadian Rockies, and it was while on the last of these that he met his death by drowning in Kinbasket Lake, B C, July 30, 1910

Shaw's broad grasp of botanical science is indicated by the following diverse titles among his published studies "Cleistogamy in Polygala," "Embryology of the Papaveraceæ," "Development of Vegetation in Morainal Depressions," "The Causes of the Timber Line," etc During recent years his interest centered more and more in ecological and physiological problems, and at the time of his death he was engaged on some fundamental investigations bearing on the influence of climate and of different light waves on plants He left a large number of instrument readings on the rate of evaporation, temperature, humidity and insolation obtained at widely different altitudes and exposures in the Selkirks which doubtless will be given to science in due time

While he was an original and clear thinker on scientific problems, Shaw was even more successful as a teacher Professor George Palmer a few years ago emphasized four essential qualities of the successful teacher (1) knowledge, (2) vicariousness, i e, the ability to take the point of view of the student, (3) clear exposition and (4) enthusiasm or the ability to inspire I have often thought of Dr Shaw as embodying these four qualities in a very high degree His knowledge was not encyclopædic, but was broad and fundamental He cared not for the out-of-the-way facts, but rejoiced in the large principles of his science It was for this reason that he advocated the choice in elementary teaching of only such topics as would rouse the student to make original observations and to draw independent conclusions His views on this principle in

teaching were presented in SCIENCE under date of September 11, 1908.

Shaw's ability to see a subject from the student's standpoint was a natural consequence of a sympathetic nature, a youthful and buoyant spirit and his simple-mindedness. There was nothing subtle about his mind and nothing covert about his nature. He was the soul of candor.

Clear exposition depends necessarily upon a clear grasp of a subject in the essentials. It depends also on sharpness of memory pictures and upon strong language powers. In all these Shaw excelled. Facts seemed to fall into his mind in their proper relationship almost without effort on his part. The knitted brow was not a characteristic of his face. Effort to clear up a thought was evinced rather by a wide-open movement of the eyes as if merely to take in all the elements of a situation and the answer was given immediately all were included. His memory for names and for essential facts was almost unfailing. The only fault in Shaw's exposition came on the expressive side. He gave the impression often of hesitation when the real trouble was not lack of *a* word, but lack of *his own word*. He was not content with the usual mode of expressing a thought. The truth to him was so engaging that it always seemed to require a special search for a word good enough to give it utterance. However, this fault, if fault it may be called, was seldom a hindrance. There was a certain clarity of thought in his very manner and his obvious sincerity won instant attention. He became quite a favorite in many places about Philadelphia as a popular lecturer.

Shaw's emotional side was as strong as his intellect. Truth for him was not merely the solution of a puzzle, nor merely beautiful, it was a sort of blessing. He cared most for that knowledge which had meaning for the largest life of the human spirit, but that meaning for him could not be expressed by any dogma, he must find it for himself. It was this quality—this deep appreciation of truth—that made his teaching inspiring. His class room was popular because through his clear vision his students got a new insight into nature, the universe, themselves.

Few men have a stronger love of nature in all her moods than had Charles Shaw. Since the age of nineteen, when first he saw the mountains he had spent some time almost every year among them. The Blue Mountains, Catskills, Adirondacks, White Mountains, Selkirks, Rockies, Alps he knew thoroughly. Nearly always he was accompanied by a party of students who learned to camp and to be content under the simplest of conditions—a shelter, a fire, a blanket. They acquired self-reliance and hardihood. They caught his love of life in the open.

Large and strong of body, Shaw was large and strong in his personality. He and I were classmates in college, were post-graduate students together and had been intimate friends ever since. He was the cleanest man I ever knew, and was the best illustration I could give of the beatitude, "Blessed are the pure in heart."

On Christmas day, 1901, Dr. Shaw was married to Miss Blanche Jackson at her home in Waterloo, Iowa. This union had the greatest influence in developing him to full, noble stature. Two most promising children are left with Mrs. Shaw. J. R. MURLIN

THE UNIVERSITY OF ILLINOIS MOVEMENT FOR A UNIVERSITY CONSTITUTION

THE first step toward carrying out the plan devised by President James of forming a constitution for the University of Illinois was taken on Monday evening, March 13, 1911.

President James on that evening met with a committee of the senate consisting of fifteen members of the faculty and outlined to them what he conceived to be the situation, the underlying problems and the possibilities. After speaking of the organization of foreign universities, including those of England and Prussia, President James called the committee's attention to the changing and shifting conditions in the universities of the United States and particularly in the states immediately surrounding Illinois.

In Iowa a new method of administration of the State University and other state schools was entered upon this last year The boards of regents were abolished and the three state institutions are being governed by one board of education, the members of which are appointed by the governor In Kansas a similar law has just been passed and awaits only the signature of the governor to make it effective

If such radical changes are to be made it would seem wiser that they should come upon the initiative of the universities themselves rather than from politicians At any rate it should be done only after a careful study of the whole situation

This senate committee at the University of Illinois is entering therefore upon an auspicious work It is expected that it will be engaged at least one year before a report will be prepared

The members of the board of trustees of the university are much interested in this undertaking for they realize the need of a definition of their duties and powers and they will be only too glad to have a statement made of the relations of the board to the state government, on the one hand, and the relations of the board to the university, on the other hand

Four leading members of the board—President William L. Abbott, Mr Fred L Hatch, for fifteen years a member of the board, Mrs Mary E Busey and Mrs Laura B Evans—were present at this initial meeting and gave it their hearty approval

The fifteen members of the senate committee that is to carry on this important work during the coming year represent (either as graduates or as former instructors) some eighteen leading universities, three law schools, three technical schools, two colleges, all in the United States and five foreign universities and technical colleges The members of the committee are the following Professor Henry Baldwin Ward, chairman, Professor Arthur N Talbot, Professor Herbert W Mumford, Assistant Professor James H Pettit, Assistant Professor Henry L. Rietz, Professor Frederick Green, Professor Ernest R. Dewsnup, Professor Julius Goebel, Mr Charles H Mills, director of the School of Music, Mr Phineas L Windsor, librarian, Professor Boyd H Bode, Associate Professor Wm A Oldfather, Professor Frederick M Mann, Professor Edward S Thurston, Mr Charles M McConn, secretary

SCIENTIFIC NOTES AND NEWS

DR HENRY PICKERING BOWDITCH, professor of physiology at the Harvard Medical School for thirty-five years, eminent for his contributions to this science, died on March 13, in his seventy-first year

DR WILLIAM H NICHOLS, president of the eighth International Congress of Applied Chemistry, was the guest of honor at a dinner tendered him by twenty-two members of the executive and sectional executive committees of that congress on March 7, at the Engineers' Club, New York City The occasion for this dinner was Dr Nichols' departure on an European trip He will visit Italy, Austria, Germany, France, Belgium, Holland and England, and to the chemists of these countries he will personally carry invitations to the congress

LIEUTENANT-COLONEL DAVID PRAIN, F.R.S., director of the Royal Botanic Gardens, Kew, has been elected a member of the Athenæum Club

WE learn from *Nature* that Professor H E Armstrong, F R S, has been nominated the delegate of the Royal Institution at the celebration of the centenary of the Royal Frederick University of Christiania, and Sir James Crichton-Browne, F R S, as delegate at the celebration of the 500th anniversary of the University of St Andrews

PROFESSOR JOSEPH P IDDINGS recently delivered two lectures before the geological department of the Johns Hopkins University on "Some Problems in Rock Classification"

DR. H. E. IVES, of the research department of the National Electric Lamp Association, delivered an illustrated lecture on "Color Measurement" at a well-attended open meet-

ing of the Case Chapter of the Society of Sigma Xi, in the physics building of Case School of Applied Science, on the evening of February 23, 1911

Mr. M N Baker, editor of the *Engineering News*, gave a lecture on March 16, before the engineering school of the University of Vermont on "The Engineer and the City"

The American Scenic and Historic Preservation Society in cooperation with the American Museum of Natural History, arranged at the museum, on March 23, an illustrated lecture on "The Physical History of the Grand Canyon District," by Professor Douglas Wilson Johnson, of Harvard University

Professor G W Ritchey, of the Solar Observatory of the Carnegie Institution at Mount Wilson, will give a lecture on "Celestial Photography," at Harvard University, on March 28 The sixty-inch mirror of the observatory is the work of Professor Ritchey's hands, and the lecture will be illustrated by recent photographs taken with that instrument

The nineteenth "James Forrest" lecture of the Institution of Civil Engineers, will be delivered on June 28, by Dr F H Hatch, his subject being "The Past, Present, and Future of Mining in the Transvaal"

The Huxley lecture at Birmingham University is to be delivered by Professor Henri Bergson, lecturer on philosophy at the University of Paris

The trustees of Columbia University have voted that the head professorship of physiology in the College of Physicians and Surgeons be named the Dalton professorship, in honor of the late Dr John C Dalton who held the chair of physiology from 1860 to 1883, and was president of the college from 1884 to 1889 The professorship is now held by Dr Frederic S Lee

We regret to record the death, on March 1, of W G W Harford, at Alameda, California Mr Harford was eighty years of age and had long been associated with the University of California, the Academy of Sciences and other institutions of research as collector, curator, etc, and was a special associate of the late Dr A Kellogg, in his botanical expeditions He published an early report on collections made in Alaska under the supervision of Professor George Davidson, and was especially interested in conchology

Mr E E Wilson, formerly assistant in the radiography department of the London Hospital, died on March 2, as the result of disease contracted by exposure to Rontgen rays

The formal opening of the Chemists' Building, 50–54 E Forty-first Street, New York City, took place on March 17, 18 and 19 At the dedication exercises the program was as follows

Address by the president of the Chemists' Building Company, Dr Morris Loeb

Address by the honorary president of the Eighth International Congress of Applied Chemistry, Dr Edward S Morley

Address by the president of the American Chemical Society, Professor Alexander Smith.

Letter from the president of Johns Hopkins University, past president of the Society of Chemical Industry

Address by the president of the American Electrochemical Society, Professor William H Walker

Address on Chemical Education by Professor Wilder D Bancroft

Unveiling of Rumford Memorial by Professor Frank Wigglesworth Clarke

Address by the president of the Chemists' Club, Dr Russell W Moore

We hope to publish a full account of the building, of the exercises and of the scientific program of the following days

A congress of technology which will give in the papers to be presented a record of the place and practical achievements of science in modern life, will be held in the buildings of the Massachusetts Institute of Technology in Boston, on April 10 and 11 The sessions will be open to the public This occasion also marks the fiftieth anniversary of the granting of the institute's charter, and the congress is therefore in part a celebration of this anniversary During these fifty years the world has seen that "advancement, development and practical application of science in connection

with arts, agriculture, manufacture and commerce," which the institute was organized to promote The institute has trained a number of men who are now in the very front rank of science In addition to this its former students are to be found in positions of power and responsibility in every state of the union, engaged in the work of developing mines, opening up the country by means of railroads, applying scientific methods to the problems of transportation, power production and distribution, advancing chemical industries, conserving the public health and contributing in countless other ways to the increase of the nation's wealth This practical application of science to the affairs of life will be surveyed and described, as also the conditions and problems of groups of allied industries, in a large number of papers by alumni and members of the faculty of the institute The papers will cover such general subjects as architecture, business administration, economics, public health and factory sanitation, industrial organization and training, power production and distribution, materials and manufacturing processes, reclamation of arid lands. The subject of scientific management will be presented from many points of view, as it may affect railroads and various manufacturing industries Among the speakers will be:

David Van Alstyne, '86, Allis Chalmers Co, Milwaukee, Wis

Henry G Bradlee, '91, Firm of Stone & Webster, Boston

Harvey S Chase, '83, Certified Public Accountant, Boston

Samuel M Felton, '73, President, Chicago Great Western Railroad, Chicago

Louis A Ferguson, '88, Second Vice president, Commonwealth Edison Co, Chicago

Walter C Fish, '87, Manager, Lynn Works, General Electric Co, Lynn, Mass

John R Freeman, '76, Consulting Engineer, Providence, R I

Charles Hayden, '90, Hayden, Stone & Co, Bankers, New York and Boston

Henry M Howe, '71, Professor of Metallurgy, Columbia University

Edwin O Jordan, '88, Professor of Bacteriology, University of Chicago

Walter H Kilham, '89, Architect, Boston

James P Munroe, '82, Executive Director, Boston 1915, Boston, Mass

Frederick H Newell, '85, Director, U S Reclamation Service

Robert H Richards, '68, Professor of Mining Engineering and Metallurgy, Massachusetts Institute of Technology

Albert Sauveur, '89, Professor of Metallurgy, Harvard University

George C Whipple, '89, Consulting Engineer, New York City

Willis R Whitney, '90, Director, Research Laboratory, General Electric Co, Schenectady, N Y

Salmon W Wilder, '91, President and Treasurer, Merrimac Chemical Co, Boston, Mass

C E A Winslow, Associate Professor of Biology, College of City of New York

THE expedition, recently sent out by the American Museum of Natural History and the New York Zoological Society, to Lower California, under the leadership of Dr Charles H Townsend, has been successful in capturing six young California sea elephants (*Macrorhinus angustirostris* Gill), on Guadalupe Island These specimens, the first ever captured alive, were sent from San Diego, California, on March 7, and arrived at the New York Aquarium on March 13, in excellent condition after their six-day trip For transportation they were crated separately and shipped by express without food or water en route Although not more than nine months old the average weight of these animals is about 250 pounds, and the length four and one half to five feet The adult males reach a length of more than twenty feet The species, which is distributed among the small islands of the southern and Lower California coast, is now verging toward extinction and very little is known of its life history or habits The common name of the species is derived from the fact that the male possesses a protrusible snout or proboscis In the young males now at the aquarium this is only slightly developed

THE path taken by Halley's comet in 1909–10 is to be shown in a series of photographs now being prepared by the committee on comets of the Astronomical Society of America, of which Professor George C Comstock,

of the University of Wisconsin, is chairman. The committee desires to secure a collection of material which will show by photographs the history of the comet from its first appearance until it was no longer visible even to the most powerful telescopes. The committee is requesting every astronomer who possesses any photographs of the comet to cooperate with them in making this history complete. The photographs used will be of four kinds: those possessing conspicuous technical excellence, those of good quality but having slight defects, those presenting obvious technical defects, and those obtained with small cameras by unskilled observers. As many as possible of the photographs used will be of the first class, but when it is necessary to make use of some of inferior excellence in order to avoid gaps in the history this will be done.

UNIVERSITY AND EDUCATIONAL NEWS

The appropriations for the U. S. Bureau of Education for the fiscal year ending June 30, 1912, show an increase of $7,600 over the appropriations for the current fiscal year, as follows: For the investigation of rural education, industrial education and school hygiene, including salaries, $6,000, one clerk at $1,600. The total specific appropriations for the bureau are as follows: Salaries, $72,800, library, $500, collecting statistics, $4,000, distributing documents, $2,500, printing annual report, $25,000, education of natives of Alaska, $200,000, reindeer for Alaska, $12,000.

The legislature of the state of Utah, during its recent session, made an appropriation of $300,000 to the State University for the construction of the main building of the institution. This building is to house the general library, the art gallery and the administrative offices. The legislature also passed a bill which has become a law, putting the support of the university and the agricultural college on a permanent financial basis by providing that these two institutions shall receive annually 28 per cent. of the income of the state derived from a 4½ mills tax. This 28 per cent. was divided between the institutions as follows: 64.43 per cent. to the university, 28.34 per cent. to the agricultural college and 7.23 per cent. to the branch normal school, a separate institution affiliated with the university. On the basis of present assessed valuations the annual income of the university for general maintenance is about $200,000. New buildings and other constructions are to be provided by special appropriations.

The legislature of Indiana, which adjourned on March 6, appropriated nearly $200,000 to Indiana University for the next biennium. This appropriation includes $150,000 additional maintenance, $35,000 of which is for the Graduate School, and $50,000 for the Medical School, for the maintenance of the Long Hospital.

According to the daily press a graduate of the Philadelphia College of Pharmacy whose name has been withheld, has offered to donate $1,000,000 toward the erection of a comprehensive group of three buildings, one of which shall be specially devoted to research work, for the institution. He stipulated that the building shall be on the Parkway on a site provided by the city. Mayor Reyburn divulged this fact in discussing his plans for making the western end of the Parkway, between Logan Square and Fairmount Park, a great center for Philadelphia's educational, engineering, scientific, historical, art and research organizations.

Mrs. Benjamin Hicks, of Old Westbury, N. Y., has bequeathed $100,000 to Swarthmore College.

Columbia University has received the sum of $693,000 from the executors of the estate of the late Mr. George Crocker, for the establishment of the Crocker Cancer Research Fund. It is understood that the remainder of the bequest is under litigation.

We are requested to state that assistant professorships of physiology, anatomy and bacteriology and pathology are to be filled in the Philippine Medical School. Information respecting the positions may be secured by addressing the Chief of the Bureau of Insular Affairs, War Department, Washington, D. C.

THE School of Engineering at the University of Pittsburgh, announces that Mr Morris Knowles, C E, will take charge of the course in sanitary engineering and public health This course will be developed in cooperation with the medical school of the university and the departments of health of the city and state The students will have a year's practical work along this line during their four years' course

THE board of trustees of the University of Illinois in its annual meeting on March 14, made the following appointments and promotions George Alfred Goodenough, associate professor of mechanical engineering, of the university was promoted to be professor of thermodynamics Professor Charles Russ Richards, dean of the College of Engineering, University of Nebraska, professor of mechanical engineering in charge of the department Professor Richards succeeds, as head of the department, Professor L P Breckenridge, who two years ago relinquished his office to take up work at Yale University Mr Burt R Rickards, of Columbus, Ohio, who has been for some three years chief of the laboratories of the Ohio State Board of Health, was appointed associate professor of municipal and sanitary dairying in the Agricultural College

DISCUSSION AND CORRESPONDENCE

LARVAL SPECIES

IN his recent review of Theobald's last volume on the mosquitoes Dr. E P Felt emphatically condemns the founding of species, or of a classification, on larval characters.[1] Dr Felt has a right to his opinion, but his remarks are so incomplete that they do not fairly present the question at issue. In the case of the Culicidæ, as in the many others that might be cited, there were causes which led logically to such a course First of these was the fact that certain species of mosquitoes could not be distinguished in the imago state, while they showed very marked differences in the larval condition This led naturally to the founding of species on the early stages and Dr. Felt himself was the first to take this step He has been amply justified by the fact that, in spite of diligent study with abundant material, no tangible characters for separating the imagos have been found It should be added that a study of the male genitalia has revealed corresponding differences, equally marked with those of the larvæ There can therefore be no question that the species indicated on larval characters really exist in nature Since then a considerable number of species have come to light which are only separable on characters of larvæ and male genitalia

Under such circumstances two courses are open to the systematist who will not recognize larval characters, neither of which, in our opinion, is scientific The most convenient is to ignore the true condition and adhere to the concept of species on the basis of well-marked differences in the imagos, the other is to admit the species indicated by the larvæ and draw up descriptions from the indistinguishable imagos To designate, as specific, individual differences due to variation, as Theobald has done in the case of *Aëdes fitchii*, *A abfitchii* and *A subcantans*,[2] only obscures the subject. We do not advocate the founding of species on larval characters as a general practise and we think that Dr. Felt expresses needless alarm on this account Under the special conditions indicated above and in similar cases we not only consider the founding of species on larval characters justified, but unavoidable Furthermore, if the mosquitoes are considered from an economic standpoint (and we are constantly told that this is the primary reason for their study) a knowledge of the larvæ is fully as important as that of the imagos

But, Dr. Felt's criticism in his approval of Theobald's position is mainly aimed at our paper on the classification of the mosquitoes by larval characters[3] He chooses to ignore the fact that we have since published a classification of the imagos, which, in the main, is

[1] SCIENCE, N S, Vol XXXIII, pp 150–151

[2] "Monogr. Culicidæ," Vol 4, 1907, pp 319, 321

[3] "The Larvæ of Culicidæ Classified as Independent Organisms," *Journ N Y Entom Soc*, Vol 14, 1906, pp 169–230, pl 4–16

in accord with that we had indicated with larvæ[4] It is now clear that the old classification, employing the relative length of the palpi in the two sexes as a primary character, is not a natural one It is true that the length of the palpi indicates, in a general way, the evolutionary state of the species The forms with the long palpi are the more primitive ones, reduction having occurred first in the female, where, on account of the feeding habits, they were most in the way, and then in the male The forms with the palpi shortened in both sexes are therefore evolutionally the highest

Unfortunately for any system based on this character, the reduction of the palpi has taken place independently at different points and on this account the forms with the palpi short in both sexes can not be associated, as was formerly done Dr Adolpho Lutz was the first, in 1904, to subordinate the palpi and to outline a natural classification Theobald has adopted this classification as the frame-work for his complicated scale-character system We have found good reason to go still further than Dr. Lutz and discard the palpi for even generic limits Aside from this it will be found, when the errors and weak points are eliminated from both, that the classification of Dr Lutz, and the one we formulated on larvæ alone, agree very closely Furthermore, the genitalia, when understood, indicate the same grouping It seems that the question of stability strongly influenced Dr. Felt in his criticism We venture to point out that only by attacking problems from new points of view can we progress. There are no fences in true science

The further salutary effect of the study of the larval characters has been to establish a more exact and homogeneous concept of generic values. The best example is the genus *Culex* Formerly the most heterogeneous elements were united under this name, and with those who work with the superficial characters of the imagos alone this is still the practise. Thus, even in the last volume of his work, Theobald associated wholly unrelated forms in this genus, while, on the other hand, forms which should be included are removed and scattered through the system on account of trifling differences in the scale vestiture We believe that an impartial and careful study of the Culicidæ from all points of view will show that we were justified in overturning the crude ideas on which their classification was based and that this was brought about through our study of the larvæ as organisms unrelated to their adults We believe that the names founded on larvæ are valid and should be given due priority The characters used are in many cases more positive and reliable than those found in the adults and are further of more evolutionary importance than those heretofore used in classifying the adults

HARRISON G DYAR
FREDERICK KNAB

[4] "On the Classification of the Mosquitoes," *Canad Entom*, Vol 39, 1907, pp 47-50

THE GERM-CELL DETERMINANTS OF CHRYSOMELID EGGS

THERE lately appeared in these columns under a title similar to the above, an article[1] by Dr R W Hegner dealing with a paper of mine[2] in which I had questioned his use of the term "germ-cell determinants" as applied to the granules of the pole disc of chrysomelid eggs As I do not quite agree with Hegner's interpretation of my position, I take this opportunity to make a more explict statement of my point of view

To my mind, a cell or tissue *determinant* suggests or implies a physiological activity that, to use a crude illustration, resembles the physical action of a dye upon impressionable metal Thus a germ-cell determinant would be something that stamps the undifferentiated cells arising from the cleavage nuclei with a specific germinal or reproductive property.

I have given evidence that what he calls "germ-cell determinants" are in all likelihood merely a part of the food stream from the nurse cells, and this Hegner admits is no

[1] R W Hegner, "The Germ cell Determinants in the Eggs of Chrysomelid Beetles," SCIENCE, Vol XXXIII, No 837

[2] *Biol Bull*, Vol XVIII, No 4

doubt correct As far as I have been able to determine, when they first enter the egg, these granules differ in no wise from those in other parts of the food stream that develop into yolk spherules

Now the early developmental features of the germ cells in this species point not so much to a process of active differentiation as one of passive isolation, which results in the pole cells retaining or preserving the reproductive potentialities of the cleavage nuclei, the pole-disc meanwhile serving as food material for the pole cells which "as a result of this special kind of nutrition undergo a peculiar method of metabolism which differentiates them from the somatic cells"—just as a certain kind of food is necessary for the early growth and development of a child, but is by no means the cause of its becoming a man instead of an ape H L WILMAN

UNIVERSITY OF CINCINNATI,
January 27, 1911

THE PYTHAGOREAN THEOREM

DR NORTHRUP's article[1] is not a proof of what is sometimes—perhaps incorrectly—called the *Pons asinorum* unless it be shown *experimentally* that the kinetic energy of a body is the sum of its energy of translation and of rotation The deduction, however, of this theorem of energy from the fundamental propositions of mechanics depends on the law of vector superposition, the mathematical expression of which involves the Pythagorean theorem In general it is not economical to derive mathematical propositions from experimental physics, moreover, the process fails to bring out that difference between mathematics and physics which is shown, for example, in Hilbert's "Foundations of Geometry" and Mach's "Science of Mechanics"

I should like to be permitted the liberty of objecting to the statement[2]

"No motion, force or acceleration which exists at the point p can produce rotation of $1-2$ about p as center This must be so, as it is axiomatic in dynamics that, when there is a force or acceleration at the center of mass only of a body, there remains no couple to produce rotation" first, because the word "axiomatic" seems to be used in the Kantian sense of "self-evident," and second, because Dr Northrup's proof (?) in no way depends on whether p has linear or $1-2$ has angular acceleration

Equation 7 of the paper expresses a geometric fact—I am tempted to say "accident" —which text-books raise to the dignity of a theorem R F DEIMEL

[1] SCIENCE, XXXII, 833, p. 864

[2] *L c*, p 864.

TO THE EDITOR OF SCIENCE Referring to your December 16 issue, if we are to have "A Dynamical Proof of the Pythagorean Theorem," why not let it be a simple one? For instance, if the force F whose rectangular components are X and Y, acts upon a particle of mass m until it has imparted the velocity q whose components in the same plane are u and v, then the work done upon the particle by X is equal to $\frac{1}{2}mu^2$, while the work done by Y is $\frac{1}{2}mv^2$ But the work done by the components is identical with the work $\frac{1}{2}mq^2$ done by their resultant Equating and cancelling the factor $\frac{1}{2}m$,

$$q^2 = u^2 + v^2$$

But the velocity components u and v are the two legs of a right triangle of which q is the hypothenuse, so that here again is our Pythagorean relation MAYO D. HERSEY

U S BUREAU OF STANDARDS,
WASHINGTON, D C

QUOTATIONS

THE TENURE OF PROFESSORSHIPS

AMONG the reforms suggested by the "efficiency expert" of the Carnegie Foundation who investigated the administration of some of the principal American universities was the appointment of professors for a brief period, so that they could be dropped without fuss whenever for any reason a change was desired His idea was to get young, vigorous men, work them hard as long as they could stand the strain, and then pension them off in the interest of efficiency Somewhat similar views have of late been expressed by several univer-

sity presidents—who would perhaps consider a president's position as quite different—and the *Popular Science Monthly* in its March number presents both sides of the case, deciding in favor of permanent tenure. President Butler, of Columbia University, in connection with the recent dismissal of a professor, took the ground that a teacher has destroyed his academic usefulness when he offends against common morality, or against "the dictates of common sense." President Van Hise, of the University of Wisconsin, takes the position that "there is no possible excuse for retaining on the staff of a university an inefficient man." And he complains that it is too often assumed that universities exist for the instructional force. "That the main thing is to give that force a comfortable and happy time, an opportunity for a somewhat easy existence as a teacher, leisure for browsing through literature, and long vacations."

Very likely to the employing class, accustomed to deal summarily with employees earning much more than a college professor, it may seem an anomaly to appoint men permanently instead of leaving them subject to a week's warning. Yet as the *Popular Science Monthly* points out, there are precedents, as in the army, the navy and the higher courts, and permanence of office, when introduced, is intended to improve the service, not to demoralize it. "It is attached to honorable offices, where public spirit and self-sacrifice are demanded, and the wages do not measure the performance."

It may be urged, of course, that in the interest of efficiency the wages should be made to measure the performance, that the teaching business should be put on a cold-blooded commercial basis, with no sentimental nonsense. Let every university bid for the best men, and discharge any employee when a more efficient man for the job can be found. The system works after a fashion in the business world, though even there its full rigor is only applied now and then by remorseless employers. The general rule even in business is that a man is retained while he gives reasonable satisfaction, even though it might be possible to fill the post in a more ideal fashion. Perhaps that, too, will come when the efficiency experts have completed their reform of American business system.

How it would work in the academic world is another matter, and opinion may differ as to whether it would produce more efficient or less efficient teachers than are found under the present easy-going old-fashioned ways. The one sure thing is that it would bring in a very different type of man. Of course if the machine is to be "speeded up" and only the young and energetic are to find a place in it, the pecuniary rewards must be made commensurate if the profession is to be made attractive to men of ability. And without doubt the offer of gorgeous salaries would draw in brilliant young men who now see nothing worth while in teaching because they can make more money in business. But that the net result would be a strengthening of the teaching force is by no means so certain. What efficiency experts sometimes forget is that there is a type of ability that can be found and retained better by the offer of a secure and dignified post than by the flourishing of money. The *Popular Science Monthly*, which is by no means sentimental, hits at an important truth when it says:

> But it appears that the general course of social evolution is not toward competition. In the university it would probably be adverse to the finer traits of scholarship and character, most of all when, as under our present system, the competition would be for the favor of presidents and trustees.

No doubt a university tends to accumulate "deadwood," and it is easy to understand the desire a president must often feel to make a clean sweep. Nevertheless it is probable that these disadvantages are more than offset by the republican spirit which prevails in the faculty of a happily governed college or university, the spirit of equality and of disinterested service. It would be a pity to have the seclusion of the university, the citadel of idealism, given up to selfish scrambling for a better "job."—Springfield *Republican*.

THE STATUS OF THE PROFESSOR

THAT the American college president fulfils a function and exercises a degree of power that has no parallel in the institutions of learning of the old world has been asserted so often and, so far as we know, has met with so little contradiction, that it is pleasing to find two leading representatives of the college presidency not so much justifying this peculiarity, but rather denying its existence In the *Popular Science Monthly* for March the editor, in an article under the title "About Dismissing Professors," quotes a comment of President Butler's upon the following remark made in this paper some months ago, in reference to the plans of Reed College, the promising new institution about to be established in Oregon

There is a fine opening for a new institution to show what a college can be wherein the personal domination by the president is abandoned, and in its stead we have a company of gentlemen and scholars working together with the president simply as the efficient center of inspiration and cooperation

"The condition described in the last four lines," says President Butler, "is precisely what is to be found at every American college and university that is worthy of the name, and no evidence to the contrary has ever been produced by anybody"

The other utterance to which we have reference is the address delivered by President Van Hise at the recent meeting of the Association of American Universities at Charlottesville, which appears in SCIENCE for February 17 Doctor Van Hise makes out a very good case for the necessity of the presidential functions, a not inconsiderable part of which case consists in pointing out the extent to which, in many of our colleges and universities, those functions, so far as appointment and promotion are concerned, are exercised only in cooperation with the faculty If anybody was under the impression that the American college president exercised his powers in the spirit of an oriental monarch habitually putting this man up and that man down, as suited his pleasure or whim, certainly the facts stated by Doctor Van Hise must show him that he was in error

The fact remains, however, that in our American colleges the president is not "*simply* the efficient center of inspiration and cooperation," but is in large measure thought of, and thinks of himself, as the master, or the foreman, or the captain, of a body of men working under his direction, and this fact has a potent influence on the whole character and spirit of academic life in America The idea of administration, of coordination, of "harmony," plays a part in most of our colleges and universities altogether disproportionate to its value Nor is the objection to this state of things merely negative There is positive harm of the most serious kind in that submergence of self-assertive personality on the part of the professors which inevitably goes with it It is not an accident that President Van Hise habitually speaks of "the instructional force of the university", he instinctively thinks of the professors not as an assemblage of individuals, each expected primarily to do his own work in his own way, but as a "force" of employees jointly engaged in the production of a certain output Nor is it easy to imagine a man who regards himself as "simply the efficient center of inspiration and cooperation" of the faculty using this language, which appears in an editorial article in the *Educational Review*

Truly the academic animal is a queer beast If he can not have something at which to growl and snarl, he will growl and snarl at nothing at all

Whether or not a bill of particulars could be made out, such as would satisfy a judge and jury, in support of the proposition that the presidents of most American colleges dominate them in the way that is generally asserted, we can not undertake to say Evidences of a less definite nature, but to our mind quite convincing, are sufficiently abundant We do not say that it is personally the fault of the presidents; it may be quite as much the fault of the professors, or the fault of something in the national make-up It may in part be due to the same traits of national character which result in the extraordinary power of the political

boss and in the amazing concentration of financial and industrial control in the hands of a few men But that no need of our university world is keener than the need of an increase in the personal importance, dignity and self-assertion of the professor, we are profoundly convinced And it is encouraging to note that on every hand when the issue arises sentiment is strongly manifested on the right side The dismissal of Professor Ross from Leland Stanford found nowhere stronger condemnation than among men thoroughly out of sympathy with his economic views, but deeply conscious of the importance of professorial independence The report recently made to the Carnegie Foundation by a mechanical engineer was at once recognized everywhere as a *reductio ad absurdum* of the idea that colleges and universities should be conducted on machine-shop principles The attempt to get the maximum of efficiency at every point by the exercise of supervision and control, even when not carried to that ridiculous extreme, is destructive of that vitality upon which the true efficiency of a university depends, and which resides in the inherent personal qualities of its professors It is the permanence of tenure of professors, the undisputed dignity and honor of their position, that have made the great universities of the old world what they are And no substitute for the vitalizing influence of these essential elements can be provided by any amount of supervisory meddling or administrative perfection —New York *Evening Post*

SCIENTIFIC BOOKS

Conduction of Electricity through Gases and Radioactivity By R K McClung Philadelphia, P Blakiston's Son & Co Pp xiv + 245

Among the many books which have appeared upon this subject within the past five years this is the first which attempts to present a definite course of instruction "suitable for the less advanced student or undergraduate" The feature which differentiates it most markedly from other books and which gives it its great importance is the presentation of detailed directions for 125 laboratory experiments The book is in fact built up about these experiments and any student who performs them all can scarcely fail to gain a fundamental grasp of the principles of gaseous conduction and radioactivity

It may perhaps be questioned whether many undergraduates will be found who will have either time or ability to perform satisfactorily all of the experiments outlined—in fact, I confess to a suspicion that perhaps no one person has ever performed all of them, for I should estimate that that would be a task requiring four or five years of continuous work by a well-trained experimenter Nevertheless, the book is a great boon for the student who is just beginning research in this field as well as for the instructor who is directing it, for it collects in compact, accessible form a multitude of practical points which are essential to successful experimenting, but which each individual experimentor has heretofore had to "dig out" for himself or else to obtain from some more experienced person by the laborious process of individual oral instruction

The one danger which will have to be guarded against is that the student by virtue of being crowded too rapidly over the experimental ground covered by practically all of the important researches in this field of the past fifteen years does not develop the habit of very superficial experimenting The book meets an important need and will doubtless receive wide use R A MILLIKAN

RYERSON LABORATORY,
UNIVERSITY OF CHICAGO,
December 28, 1910

Die Ernahrung der Wassertiere und der Stoffhaushalt der Gewasser Von AUGUST PUTTER Jena, Gustav Fischer. 1909. Pp 168. Price M. 5 0

Dr Putter's researches on the food of aquatic animals have called attention to a source of supply which had been almost or quite disregarded Some of the views expressed in his earlier papers met with more or less criticism because the results obtained by other investigators were not always in accord

with his theories and the present volume is a welcome contribution because Dr Putter gives a more detailed presentation of his views and replies to the more important objections offered by his critics

The first chapters are preparatory to the discussion of the chief topic, i e, how aquatic animals obtain an adequate supply of food They deal with such questions as the intensity of metabolism in the various groups of aquatic animals, the food requirements of these animals, the different types of food of various groups, including both vertebrate and invertebrate forms, and the source of organic substances dissolved in the water The view is presented that the estimation of the food requirement of an animal should be based upon the area of active absorbing and secreting surfaces, more especially the effective respiratory surface, rather than upon the mass, because the oxygen consumed is a good measure of metabolism, and the rate of consumption of this gas shows the intensity of this process Calculated on this basis, the author finds that the food requirement of many aquatic animals has been greatly underestimated hitherto and that the total demand in a body of water is frequently greater than the supply of organized food which is produced by it One instance is cited in which the demand for food by the zooplanktonts of a body of water exceeded the supply of organized food for nine months out of a period of thirteen, and in another instance demand exceeded supply for each of thirteen months Naturally, this excess of demand over supply raises the question as to how this deficit is made good and the author's answer to this query is his important contribution to the subject under discussion

Dr Pütter maintains that aquatic animals have recourse to the organic substances which are always found in solution in natural waters, and in this way the deficiency is supplied He asserts, in fact, that these dissolved organic substances which are generally present in amounts varying from ten milligrams to twenty milligrams per liter of water are not only drawn upon in emergencies, but that they are the chief source of the food of some forms

With respect to the ability of aquatic animals to make use of dissolved food an experiment by Knorrich is cited in which *Daphnes* survived for a period of fourteen days on a diet consisting solely of dissolved food The author himself found that goldfish lived for a period of forty-one days in tap water which contained no organized food and the oxygen consumed substantially accounted for the loss in weight, but when organic substances were dissolved in the tap water, the goldfish survived for seventy-eight days, nearly twice as long, and the oxygen consumed greatly exceeded the amount that would account for the loss in weight The conclusion drawn from this experiment is that these goldfish were able to make use of the dissolved food, because they lived so much longer when supplied with this kind of food than when given neither dissolved nor solid food, and because of the extra quantity of oxygen consumed

Solid food is not regarded as a thing which may be dispensed with entirely, but dissolved food may play a more or less important rôle, even to the point of being the chief source of food for some organisms, such as sponges, which frequently appear to receive very little in the way of organized food

Dr. Putter's conclusions are not always convincing and there is a paucity of evidence in some instances which serves to show how recently this field has been invaded by investigators, but the views expressed are suggestive and will doubtless stimulate investigations in this field of research and eventually result in giving us a much better knowledge of the nutrition of aquatic animals

C JUDAY

THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE
SECTION E

THE regular annual meeting of Section E of the American Association for the Advancement of Science was held in Pillsbury Hall, University of Minnesota, December 27, 28 and 29 A program of papers was read both morning and afternoon each day Due to the unavoidable absence

of Mr. Brock, the vice-presidential address on "Northern Canada" was not read on Wednesday afternoon, but read by title only.

The Weathering and Enrichment of Pyritic Gold Ores: W. H. EMMONS.

Any theory of leaching or enrichment at depth of auriferous deposits involves the solution, transportation and precipitation of gold in cold and moderately dilute solutions. The analysis of underground waters shows that sulphuric acid and sodium chloride are present in practically all waters from pyritic gold mines. Gold is dissolved by nascent chlorine, which in acid solutions is set free by nitric, manganitic, ferric or cupric compounds. Since nitrates are seldom shown in the analyses, they are believed to be of little or no importance in this connection; ferric and cupric compounds release nascent chlorine only in hot or in concentrated solutions. As shown by Brokaw's experiments appreciable gold is dissolved in fourteen days in cold solutions containing but 1,418 parts per million of chlorine, when manganese is present. In a similar solution without manganese no gold is dissolved. As shown by McCoughy a very small amount of ferrous salt will precipitate gold dissolved in chlorine solution. Consequently the auriferous solution could not travel far through deposits where pyrite is oxidizing to ferrous sulphate. But manganitic compounds such as pyrolusite very quickly oxidize ferrous salt to ferric salt. Thus manganitic compounds not only release the nascent chlorine which dissolves gold but they also inhibit the precipitation of gold by ferrous salt, thus permitting the gold to travel farther in solution.

But these laws apply only to acid solutions. At greater depths where acid is used up to form neutral or basic salts by reactions with the wall rock, the system breaks down and gold together with manganese oxide is precipitated. Indicating these reactions certain manganiferous gold deposits are found in depth to consist of pyritic gold ore cut by fractures which are filled with rich veinlets of auriferous powdery manganese oxide (probably manganite, in the main).

It follows from these premises that manganiferous gold deposits are less likely to yield gold placers than non-manganiferous deposits; that outcrops of manganiferous lodes are more likely to be leached of gold near the surface, that non-manganiferous lodes are less likely to contain secondary gold bonanzas. It is believed that these relations are indicated by the pyritic gold deposits of the United States.

The Genesis of Certain Greensands of Minnesota: N. H. WINCHELL.

The greensands discussed were (*a*) that which occurs in the valley of the Blue Earth River, discovered in 1700 by Le Sueur and mined by him in the belief that it was an ore of copper, and (*b*) that which occurs on the Mesabi iron range, called glauconite and greenalite, and regarded by some as the source of the iron ore of that range and of other Lake Superior iron ranges.

The former was shown to be so closely associated with the residual products, such as kaolin, that it must be considered to result from the decay of the Upper Cambrian strata with which it is found. The chemical and physical characters were given, samples were shown, and finally, photographs of the bluffs showing the deep disintegration of the strata along the Omaha Railroad. Kidney iron ore (with the shape of limestone pebbles, which have been a standing puzzle to Minnesota geologists) was another product of this same disintegration, which was in some way dependent on the presence of the Cretaceous ocean, which covered the locality.

The greensand of the iron ore ranges of Minnesota has been reinvestigated by means of thin sections of a drill core furnished by Mr. E. J. Longyear, of Hibbing. This core was representative of a drill that went through the Mesabi rocks, to a depth of 2,049 feet. One hundred and six thin sections were examined. Throughout the core, beginning at the top of the black slate and continuing to near the horizon of the iron ore, the rock is characterized by the predominance of an isotropic substance in grains of all shapes, evidently sedimentary, though seldom in distinctly detrital or rounded forms. The supply of material was so rapid that there was not enough friction to round the grains thoroughly. Mingled with these grains are angular grains of quartz and other minerals. The isotropic grains resembling glass, are seen to contain bubbles and globular incipient minerals. They are sometimes slightly greenish, and sometimes brownish, but have a high index of refraction. They are sometimes partly and even wholly opaque, and black, and when opaque they are variable in form. These obvious primary microscopic characters indicate that this isotrope is of volcanic glass, and the secondary microscopic characters agree with

that conclusion Quartz, actinolite, calcite and iron ores appear as alteration proceeds, and their relations have been noted The green mineral first appears at a depth of 1,508 feet, where it is only partially developed and hardly to be distinguished from the isotropic glass It occurs in various *forms* and first attracted attention as it took the rounded form of the original glass pellets, wholly free from other secondary minerals The detailed relations were examined Geodic structure often appeared

Inasmuch as these several secondary minerals often lie in a matrix of greenalite, it has been assumed that they have been developed from the greenalite by chemical separation But an identical fact is seen in the relations of secondary quartz Magnetite, actinolite, and even greenalite and calcite are similarly surrounded by quartz. From analogy, one might assume that these minerals were generated from quartz On such an assumption any one of the minerals could be proven to be derived from any of the others

These considerations put a veto on the idea that the iron ore is derived from the greenalite It is a secondary product coordinate and connate with the quartz and with the iron ore

An Example of Limonite Deposition. OLIVER BOWLES

A small occurrence of limonite at Sturgeon Lake, in the Thunder Bay District of Ontario, is described Surface waters have dissolved pyrite from a pyritic quartz vein which is exposed on a hillside, and the dissolved iron is deposited in the form of a limonitic cement amongst the pebbles of the talus slope

The points to which attention is specially directed are (1) evidence of total solution of pyrite by rain water assisted only by dissolved gases, (2) the large extent of the deposit when compared to its limited source of supply; (3) the presence of ferrous sulphate as an intermediate stage in the process of alteration The unstable nature of ferrous sulphate when considered in connection with the close proximity of the pyrite and limonite would lead one to expect that limonite deposits of pyritic origin, in regions free from carbonate reaction, would be found close to the source of supply

The Geology of the Cuyuna Iron Ore District of Minnesota CARL ZAPFFE.

Cuyuna District is located in central Minnesota and is the youngest iron ore district in the Lake Superior region No rock outcrops point directly to its location, but its existence was conjectured from the geological structure of the Lake Superior region as a whole and that of the different iron ore districts embraced therein Numerous well-defined belts of magnetic attraction enable systematic and productive explorations with diamond drills, and the geology of the district has been determined solely from carefully collected data of about 1,900 drill holes The geology of the district is interpreted to be that of a closely folded heterogeneous slate formation of Upper Huronian age and containing in its lower horizon interbedded sedimentary lenses of iron bearing formation which, upon being exposed by folding and erosion, have frequently altered through descending meteoric waters into low grade iron ores at the erosion surface Basic post Huronian igneous rocks seem to be exclusive within the ore bearing area and predominate over the acid phase in the outlying areas

The Relation of Texture to the Composition of Coal FRANK F GROUT

Proximate and ultimate analyses are reported of seven samples from a coal mine at Marshall, Colorado The samples represent different textures from a single seam, and in the report they are distinguished by the following names (1) average, (2) glance coal, (3) splint coal, (4) mineral charcoal or "mother coal," (5) cannel-like coal, (6) resin? (7) slate, (8) bone coal

It is seen that the average of the seam is sub bituminous, but that by any of the standard methods of chemical classification the small samples vary from lignite to semi-bituminous coal. The analyses have considerable importance in discussions of the origin of coal, and further, may explain some of the variation in samples from a single seam It is well known that such constituents as the resin and charcoal occur quite erratically in various parts of the mines

The Geology of Harding County, South Dakota: ELLWOOD C PERISHO.

This area is located in the northwest corner of South Dakota Topographically the chief feature is a plain about 3,000 feet in elevation with several buttes and a few valleys The buttes are about 500 feet high; good examples are Cave Hills, Short Pine Hills and Slim Buttes, while the chief valleys are the Little Missouri, Grand and Moreau. The geological formations are the Fort Pierre, Cretaceous to Loup Fork and Mio

cene Unconformities occur between the Fort Union and White River and between the White River and Loup Fork, while folds and faults occur locally in the Pre Loup Fork beds of Short Pine Hills, etc There are few fossil plants and animals Coal (lignite) of lower Fort Union age occurs in seams a few inches to ten feet thick

The buttes are attributed to either (1) a chert layer of the White River, (2) a massive Fort Union sandstone, (3) local thick coarse beds of Loup Fork, (4) combinations of the above

Soil has been extensively removed and caves worn in the cliffs by the work of wind At Slim Buttes and Short Pine Hills extensive slumping has developed Some terraces in the Little Missouri Valley may be due to the post Pliocene climatic changes

Northern Canada (address of the retiring vice president) R W BROCK Read by title only

Geology of the Olympic Peninsula, Washington · A B REAGAN

In the Olympic Peninsula the following formations are exposed (1) Old Cretaceous (Point of Arches group), (2) Cretaceous and possibly older (Point Granville, Pacific coast in general, and central high area), (3) Eocene (Volcanics near Port Crescent), (4) Oligocene Miocene (Fresh Water Bay and east of Gettysburg flank of the Point of Arches Group), (5) Pliocene (Hoko formation on the Strait, Raft and Quinault formations toward Point Granville, and Quillayute formation in the interior to the northeast of La Push on the Pacific), and (6) Pleistocene (covering all the region but the upper stretches of the eastern tributaries of the Quillayute River) In all between 20,000 and 30,000 feet of rocks are exposed

The rocks of (4) contain many fossils very similar to the Tertiary near Astoria, Ore They are also coal bearing, the Clallam Bay Mine producing 200 tons or more per month Coal is also exposed in the Quillayute Bogachiel country and on the Pacific coast near Cape Johnson, and also near the Point of Arches Oil springs occur at Hoh Head, on the Pacific side of the peninsula

The Geologic Map of North Dakota A G LEONARD

The geologic formations represented on the map are the Benton, Niobrara, Pierre, Fox Hills, Lance (*Ceratops* beds)?, Fort Union and White River The Benton and Niobrara occur in the northeastern corner of the state, in the Pembina Mountains The black to bluish gray Pierre shale covers most of the eastern half outside the Red River Valley, and also outcrops in the Missouri River Valley for twenty miles above the South Dakota line, and in a small area in northwestern Bowman County The Fox Hills sandstone occurs in the latter locality and on the Missouri River as far north as old Fort Rice The Lance beds cover a large area in south central North Dakota, and a smaller area in the southwestern corner of the state The Fort Union occupies much of the western half of the state, and in it most of the lignite beds are formed The White River beds form several small areas in Billings County

The character of the various formations is discussed

A New Use of Lignite E J BABCOCK.
Read by title only

Coals and Clays of North Dakota E J BABCOCK
Read by title only

Geologic Features of Nebraska E H BARBOUR
Read by title only

Lake Superior as a Former Igneous Center · ROBERT BELL
Read by title only

The General Structure of the Florence Iron District W O HOTCHKISS

The Florence Iron District is the extension into Wisconsin of the Menominee district of Michigan The Quinnesec schists south of both districts have been considered to be the basement on which the iron bearing series was deposited and therefore the possibility of developing new iron districts to the south deemed very slight Work of the past field season has shown that these schists overlie the iron bearing series The general structure of the Florence district is monoclinal from a broad point of view, with local folding in the slate series in which the iron formations are interbedded

The iron bearing series has a southward dip and disappears under the schists This makes it more probable that the series may reappear beneath the glacial drift to the southward and makes careful work in the drift covered pre cambrian area to the south of great economic importance

The Geothermal Gradient ALEXANDER N WINCHELL

It is generally agreed that the earth is a cooling body Calculations of the thermal gradient within the earth, based on the laws of a cooling body, have shown that the gradient thus derived does not deviate from a straight line to any important amount within a depth of fifteen or twenty miles

Therefore, it has been assumed that temperatures approximating fusion conditions would be found at about twenty miles depth, but such computations ignore the effects of radioactivity on the geothermal gradient. Therefore the subject needs reexamination in light of new data.

A study of the subject leads to the conclusion that radioactivity supplies not less than one sixth nor more than one half of the annual heat loss of the earth. It appears, further, that this source of supply of heat must be largely concentrated near the surface of the earth. Therefore, the actual temperature gradient within the earth can not be approximately a straight line, as derived from the laws of cooling, but must curve constantly and at a rate which depends upon the amount of heat produced within the earth by radioactivity at various depths. After making due allowance for the effects of radioactivity and cooling upon the geothermal gradient it appears that temperatures approximating fusion conditions are to be expected at a depth of about thirty miles instead of twenty miles. Further, it appears that if radioactivity supplies much more than about one quarter of the annual heat loss of the earth the nebular hypothesis as ordinarily understood must be incorrect.

Finally (as pointed out by Becker), by making proper allowance for the effect of radioactivity, Kelvin's estimate of the age of the earth is brought into harmony with the best estimates derived from other sources, instead of standing as heretofore, as a perpetual challenge to the accuracy of other estimates.

Terrestrial Deposits of Owen's Valley, California. ARTHUR C. TROWBRIDGE.

Alluvial deposits occur as fans and piedmont alluvial plains on either side of Owen's Valley, Cal. On the Sierra side the deposits are fluvioglacial. At the foot of the Inyo Mountains there are deposits of two ages. The materials range in size up to bowlders thirty feet in diameter. They are sorted roughly into lenses and pockets. The fans are now being dissected. The cause of deposition is decrease in velocity and volume of streams from the mountains.

Huge bowlders are transported in the following manner. The stream moves fine material from in front of the bowlder and piles other material behind it. As the bowlder is undermined it falls over into the depression. This process is repeated time and again, resulting in periodic motion for the bowlder.

Dissection has followed great fluvio glacial deposits on the surface of the fans, these deposits bearing relations to present conditions similar to those between a valley train and normal stream erosion.

Criteria are presented for the distinction of such deposits from still water deposits.

Note on a Method in Teaching Optical Mineralogy. F. W. MCNAIR. (To be published in *Am. Jour. Science.*)

In the effort to condense optical mineralogy, the form of the wave shell and deductions therefrom have been rested as directly as possible upon the so called reciprocal ellipsoid of McCullough. If one may judge by the text books, the ellipsoid, whether that of Fresnel or this of McCullough, is used in the non mathematical presentations of the subject to obtain the wave shell or its three principal sections, and is then immediately abandoned. The device, which occurred to me some years since and which I have found useful in obtaining results with my students, is to carry the use of the ellipsoid into a considerable number of the applications of the theory to the properties of crystals. Perhaps the most conspicuous example of its usefulness lies in its application to the distinction between positive and negative crystals in convergent polarized light. Details can not be abstracted.

Its justification rests in the readiness with which a student who once comprehends the meaning of the ellipsoid becomes independent in his application of the test of the quartz wedge, applying the wedge in either position and reasoning out his results with an assurance of correctness.

Indications of a Huronian Continental Angle. H. B. AYERS.

A belt of Huronian beds will probably be found parallel to the Rocky Mountains through the Dakotas, Alberta and northwestward, forming a continental angle with the Minnesota belt probably in the vicinity of the Black Hills. A few outcrops of quartzite and slates and some topographic and drift data supply the foundation for the conjecture.

The Dam Lake Quartzite. H. B. AYERS.

The quartzite of Dam Lake (Aitkin County, Minn.) has been explored by drilling through both contacts with adjoining rock and the results prove it to be the equivalent of the Pokegama quartzite, and here overlying the Keewatin formation.

Evidences of Pleistocene Crustal Movements in the Mississippi Valley: J. E. TODD. Read by abstract.

Recent studies show that the glacial deposits of Kansas indicate: (1) A marked easterly trend. This appears from the direction of striæ, character of bowlders, etc. The ice came from the Minnesota valley, not from the Dakota. (2) The edge of the ice reached, in Pottawattamie County, Kansas, an altitude of 1,500 feet A. T. Taking a common point in northern Kossuth County, Iowa, and assuming a uniform average slope, it is shown that with the surface at present altitudes, if the ice reached Blaine, Kan., in the Kansan epoch, it should have reached scores of miles farther east in northeastern Iowa, and seventy or eighty miles further southeast in central Illinois, than any trace has yet been found. From this it is argued that the surface at that time was higher in the latter localities and lower in Kansas.

Corroborating facts are found: (1) in the trough of the Mississippi being 100 to 200 feet deeper than is now necessary to fit the present levels of drainage, while (2) in Kansas the levels of pre-glacial drainage and Kansan drainage were 80 to 100 feet higher than at present. (3) The stronger easterly trend in eastern Iowa of the ice of the Iowan epoch, as compared with that of the Kansan agrees with the conclusion that the change of levels took place between the two epochs, presumably in response to the presence and weight of the ice.

Fault Scarps of the Basin Ranges: CHAS. R. KEYES. Read by abstract.

In the instance of the Basin-Range type of mountain structure normal faulting on a prodigious scale was long regarded as the principal factor. Its mountain block was considered as upraised. The face of the hard mountain rock rising abruptly out of the less resistant valley deposits was believed to represent a true fault scarp. This hypothesis is not exclusive; nor is it very satisfactory.

A main objection to the theory is the fact that the evidences of recent displacement are seldom ever disclosed at or even near the so-called fault-scarps. Whenever the line of major faulting is discovered it is miles away from the mountain foot—out on the intermont plain.

On the theory of general denudation of arid regions chiefly through means of eolic rather than aqueous agencies the belt of maximum deflation is at the foot of the desert ranges—where the mountain meets the plain. Within the limits of this narrow belt the topographic result is a tendency towards a steep, plain-like slope. This piedmont belt chances also to be the horizon where torrential water action is most pronounced, cutting deep canyons in the mountain and spreading out detrital fans on the plains. In the struggle between water and wind for corrosive supremacy the results in the mountain area are a succession of sharp ridges trending at right angles to the range axis, sharply truncated at their lower end by deflative action. The faceted mountain foot thus produced resembles closely the ideal effects of a fault-bounded upraised mountain block the dissection of which is well advanced.

Modified Drift in Minnesota: WARREN UPHAM.

In respect to their origin and mode of deposition the drift formations of the Ice Age comprise two classes: (1) glacial drift, in the various phases of the till and morainic deposits, produced directly by the agency of ice-sheets, without modification by water; (2) modified drift, derived from erosion and transportation by land ice, but also to some extent transported and deposited by water, being thus waterworn, assorted and more or less stratified.

This second class of the drift deposits, described in its development in Minnesota, includes the valley drift gravel, sand and clay, and also frequent tracts of sand and gravel plains outside the present courses of drainage, but occupying areas where considerable streams of water, well laden with sediments, were discharged from the melting and retreating ice fields. Relatively small parts of the modified drift are amassed here as kames and eskers, which are respectively knolls and long ridges of gravel and sand formed by the brooks and rivers of the glacial melting, the heaped and ridged form of these deposits being due to accumulation at the mouths and in the ice-walled channels of the streams.

The ratio or proportion of the modified drift and glacial drift in Minnesota is estimated as one to three or four. This somewhat large proportion modified and deposited by water, is regarded by the author as an evidence that much of the drift was contained in the lower part of the ice sheet, and that it was finally exposed on the surface of the waning ice fields to the action of streams formed by the melting and by attendant rains.

Fluctuations of the Keewatin and Labradorean Ice Currents in the Vicinity of Minneapolis and St. Paul: WARREN UPHAM.

The currents of glaciation in western and south-

western Minnesota moved to the south and southeast, bringing gray till, with plentiful limestone bowlders, cobbles and finer drift This area was a part of the Keewatin division of the continental ice sheet, with outflow southward from Manitoba, Saskatchewan and Keewatin In northeastern Minnesota the glacial currents belonging to the outer part of the broad Labradorean ice field, moved to the southwest and south, bringing reddish till, colored by the red sandstones and shales of Lake Superior The red drift is destitute of limestone bowlders and detritus, because that part of this state and the adjoining region northeastward have no limestone formations The Keewatin and Labradorean currents were confluent, or they met and opposed each other on a belt that extends from St Paul and Minneapolis northward and northwestward through Minnesota to the vicinity of Winnipeg

Gray drift forming the surface and overlying the red drift on a large tract from Lake Minnetonka east and northeast to Rush City, Minn, and to the contiguous border of Wisconsin, shows that after the edge of the Labradorean ice field had occupied that area its drift was covered by an advance of the edge of the Keewatin ice field

Numerous sections in St Paul, observed in the distance of about three miles from the new capitol to Lake Como, show that stratified drift gravel and sand, mostly from the northwest, with abundant limestone, are covered by a thin surface deposit of till from the northeast, having no limestone The latest fluctuation of the waning ice sheet there is thus known to have been a readvance of the Labradorean margin, spreading a thin mantle of its englacial till

The Glacial Lake of the Fox River Valley and Green Bay and its Outlet S WEIDMAN

An introductory statement was made of the succession of glacial lakes in the basins of the Great Lakes, and the generally accepted theory of their origin by ice dams on the retreat of the latest (Wisconsin) ice sheet Professor Upham pointed out the probable existence of such a lake in the Fox Valley, suggesting the name Lake Jean Nicollett, but not describing the shore lines or outlet. Recently discovered shore lines in the valley and about Green Bay occur at about 20, 40, 70, 95, 150, 220 and 250 feet above the present level of Green Bay. The higher shore lines are at 800 and 830 feet above sea level, developed on the outlet to the Mississippi River by way of the Wisconsin, the outlet being below the mouth of the Baraboo River, south of Portage The lower shorelines marked stages in the lake with outlets probably first through Lake Chicago and later through to the Atlantic The shore lines appear to be horizontal throughout

The outlet for altitudes of 800 and 830 feet developed across what seems to have been the divide between the Fox and lower Wisconsin River systems, this divide being between the mouth of Baraboo River and Merrimac The Wisconsin River above Portage was formerly a part of the Fox River system, and through the development of the lake outlet was captured by the lower Wisconsin, a tributary of the Mississippi During flood the Wisconsin now overflows to the Fox across the low flats in the vicinity of the canal and old Indian portage at Portage, the overflow following approximately the former course

Characteristics of the Glacial Drift Sheets in Minnesota FREDERICK W SARDESON

A brief historical review of recognized drift sheets in Minnesota, the Old Drift, the Young Drift and recognizable divisions of these, were given, followed by a description of their general characters Local variations in the character of the several sheets were considered with discussion of means employed to identify them under various conditions The progress of new investigations by Leverett and others in Minnesota was also represented

The Pleistocene of a Portion of the Missouri Valley B SHIMEK

A discussion of the distribution and extent of the Nebraskan drift, the Aftonian interglacial silt, sand and gravel, and the Loveland joint clay, as revealed by recent field studies Evidence that the drift of the extreme northwestern part of Iowa, and adjacent territory is Kansan, and that the Wisconsin is absent from that section. The wide distribution of at least two loesses is noted.

The Æolian Origin of the Loess B SHIMEK.

The evidence furnished by distribution, composition and fossils is briefly reviewed Elimination of fossils formerly improperly included in the loess series Additional evidence furnished by observations on the drifting of sands, dust and snow, on plant distribution and distribution of the loess along streams. A brief summary of objections to all other theories of origin of loess

Chains of Lakes in Martin County, Minn., as Evidence of Extensive Recession and Readvance of the Ice sheet WARREN UPHAM Read by abstract only

Three series of lakes extend across Martin County, one of the central counties of the most southern tier in Minnesota Till forms the moderately undulating and almost level country inclosing these lakes, which are usually joined by a stream In several places, however, a watershed passes across a lake chain, and such higher divides between closely adjoining lakes of the chain likewise consist of till, retaining their contour as molded by the ice sheet, without effects of water in deposition or in erosion These very remarkable chains of lakes seem explainable only by regarding them as proofs of a fully developed interglacial system of drainage running there from north to south, which became afterwards ice enveloped in the Iowan and Wisconsin stages of the glacial period

Near Rush City in Chisago County, about fifty miles north of St Paul, and at Barnesville, Clay County, in the southern part of the Red River Valley, fossiliferous beds and associated modified drift were overspread by till of a later glacial readvance Probably this renewal of glaciation covered nearly all the south half of Minnesota, extending over Martin County with partial filling of its interglacial river courses, and continuing to the most southern limits of the Wisconsin drift sheet west of the Mississippi River, near Des Moines, Iowa, distant from Barnesville about 400 miles to the south southeast

The Glacier National Park M J ELROD

About 125 colored lantern slides, mostly from the author's negatives, showing the condition, surroundings and effects of the several glaciers of the park.

Observations on Changes of Level on the Atlantic Coast Line from Cape Cod to Cape Race (Newfoundland) G C CURTIS Read by abstract only

A series of observations have been completed on the coast and outlying islands between Cape Cod and Cape Race The general character is that of old mountains partly submerged and subsequently elevated Local differential movements appear to be a characteristic throughout the area Sections of coast plain alternate with fiorded indents Since glaciation there has been a very general elevation of between twenty and forty feet, sometimes more and sometimes practically none. In general the Nova Scotia coast appears to have remained longer at the present level than that of Maine. The character of local coast features has been modified by glacial drift.

The Contribution which the Naturalistic Model is bringing to Earth Science G C CURTIS Read by abstract only

Up to the last decade, representation of the earth's surface has been generally held an empirical subject Modern science has permitted its development along natural principles To day it may be considered an exact art based on the laws of nature We are just beginning this work, which has probably the power to bring a more general interest and better appreciation for the land on which we live than has before been possible The distinction between the diagrammatic relief map and the true model is now being generally used, under the auspices of Alexander Agassiz, a naturalistic model of the topographic type has been made of the coral island Bora Bora, and installed in the Museum of Comparative Zoology (Harvard) The naturalistic model is the most perfect representation that can be made of the earth's surface, giving a truer conception of the forms of geography than can possibly be obtained otherwise The results based on following natural principles are so far superior to those of the mechanical methods and the work has so different an appearance that it seems like a different subject

Geographic Influences in the History of Michigan: G J MILLER Read by title only

Original Geographic Work ROBT BELL Read by title only

Reciprocal Intercision by Parallel Streams G H CHADWICK Read by abstract

Two parallel streams cut through the beaches of former Lake Iroquois, in the town of Lorraine, Jefferson County, N Y When close to the lake, these streams meandered somewhat, and one captured a tributary of the other Since the lowering of the lake level, both streams have cut gorges in the soft shale In much more recent times, the tributary mentioned has, in one of its meanders, up stream from the first point mentioned, cut through the wall of the larger canyon and given itself up, it can hardly be called a capture by the larger stream.

Artesian Water of South Dakota: ELLWOOD C PERISHO Read by title only

The Material Conditions of a Municipal Water Supply. C. W HALL

A study has been made of the water from all the local geological formations and from the various surface sources Several points are worthy

of special notice (1) A general tendency toward an increase in hardness with depth, or with age of the rocks from which the water is drawn (2) A tendency for the hardness of the water to decrease, if drawn extensively and continuously from a certain sandstone for several years (3) The clear evidence furnished by the chlorine determinations, of pollution of surface waters and shallow wells in the cities. In south Minneapolis—the older, more densely settled part of town—shallow well waters contain 44 parts per million of chlorine, while in other, less settled parts, 4 parts per million is the maximum A few analyses follow

	1	2	3	4	5	6	7	8
Total solids	202.1	247.3	303.9	288.5	346.9	220.0	327.6	280.0
Silica	16.6	18.2	11.6	12.3	16.8	5.0	13.1	6.7
Iron oxide, etc	.7	1.4	1.9	1.3	6.7	.6	3.1	2.2
Calcium	40.3	52.2	60.1	63.1	95.1	57.5	75.8	51.6
Magnesium	12.7	16.8	25.1	26.1	24.6	22.0	29.1	20.1
Sodium and potassium	4.9	14.1	7.1	9.4	11.3	6.8	6.8	10.2
Carbonate radicle	trace	4.2	.8	2.6				
Bicarbonate radicle	201.3	207.8	298.2	338.6	414.5	278.0	377.5	252.0
Sulphate radicle	9.5	10.6	14.0	8.4	19.8	4.0	15.5	2.7
Chlorine	2.2	8.8	5.3	5.6	6.9	4.6	2.4	5.3

It is noteworthy that samples number 6 and 8 from St Paul have lower mineral content than samples number 5 and 7 from Minneapolis, though from the same formations The amount of water taken from these formations in St Paul is much greater than in Minneapolis

1 Lake and river waters
2 Waters from wells in glacial drift
3 Saint Peter sandstone waters
4 New Richmond sandstone waters
5 Jordan sandstone waters of Minneapolis
6 Jordan sandstone waters of St Paul
7 Dresbach sandstone waters of Minneapolis
8 Dresbach sandstone waters of St Paul

FRANK F GROUT,
Acting Secretary

SOCIETIES AND ACADEMIES

THE AMERICAN MATHEMATICAL SOCIETY

THE one hundred and fifty second meeting of the society was held at Columbia University on Saturday, February 25 Thirty eight members attended the two sessions President Henry B Fine occupied the chair The council announced the election of the following persons to membership in the society Dr Elizabeth R Bennett, University of Nebraska, Mr Daniel Buchanan, University of Chicago, Dr H. B. Curtis, Columbia University; Mr L L Dines, University of Chicago, Professor C R MacInnes, Princeton University, Professor Eva S Magiott, Ohio Northern University, Mr R E Root, University of Chicago, Professor Sarah E Smith, Mount Holyoke College Six applications for membership were received

The following papers were read at this meeting

E J Miles "Some properties of space curves minimizing a definite integral with discontinuous integrand"

N J Lennes "A necessary and sufficient condition for the uniform convergence of a certain class of infinite series"

N J Lennes "Duality in projective geometry"

G A Miller "The number of the abelian subgroups in the possible groups of order 2^m"

C N Moore "On the uniform convergence of the developments in Bessel functions"

G D Birkhoff "A direct method for the summation of developments in Lamé's functions and of allied developments"

Edward Kasner "Equitangentials in space"

Edward Kasner "Conformal and equilong invariants of horn angles"

J A Eiesland "On a contact transformation in physics"

D C Gillespie "Definite integrals containing a parameter"

Joseph Bowden "The Russian peasant method of multiplication"

N J Lennes "A direct proof of the theorem that the number of terms in the expansion of an infinite determinant is of the same potency as the continuum"

Harris Hancock "On algebraic equations that are connected with the cyclotomic equations and the realms of rationality which they determine"

W B Fite "Irreducible homogeneous linear groups of order p^m and of degree p or p^2"

The next meeting of the society will be held at the University of Chicago on Friday and Saturday, April 28–29 On this occasion Professor Maxime Bôcher will deliver his presidential address, the subject of which will be "Charles Sturm's Published and Unpublished Work on Differential and Algebraic Equations" Except for the summer meetings, this will be the first convention of the whole society since 1896. A large attendance is expected from both east and west

The San Francisco Section of the society will meet at Stanford University on Saturday, April 8.

F. N COLE,
Secretary

THE AMERICAN PHILOSOPHICAL SOCIETY

The Investigation of Explosives at the Pittsburgh Testing Station Professor CHARLES E MUNROE, Washington, D C

The many and increasing number of accidents giving rise to serious casualties that have attended the mining of coal has in recent years led thoughtful men to inquire into the causes of such accidents with a view to their prevention Among other causes, it was found that the improper use of explosives, or the use of improper explosives had often operated to produce these accidents, and it appeared evident that here was a cause that ought, by study of materials and methods, to be remedied This study was begun some years ago, but it was much advanced when, following a series of disasters in the fall of 1907, by which 623 men were killed, Congress appropriated money for the investigation A testing station was opened at Pittsburgh in the following year, where the explosives could be exploded, under known conditions, in the presence of sensitive fire damp and of coal dust laden air A standard was fixed upon which the explosive must satisfy An explosive which passes the test is styled a "permissible" explosive and its name is published The list about to be published by the Bureau of Mines will contain the names of 69 permissible explosives made by sixteen different American manufacturers These explosives are sometimes styled "short flame" or "safety" explosives, but the term "safety" is improper. According to a canvass by the Bureau of Mines, 8,942,857 pounds of short-flame explosives were made in 1909 Professor Munroe, with the aid of lantern slides, described the apparatus employed and its method of use

THE BOTANICAL SOCIETY OF WASHINGTON

THE 70th regular meeting of the society was held at the Cosmos Club, Tuesday, February 7, 1911, at 8 o'clock P M In the absence of both president and vice president Dr W H. Evans was chosen chairman pro tem Thirty one members were present Dr C O Appleman, E G Boerner, G N Lamb, W J Morse, C A Reed, Wm Shear, C B Smith, A V Steubenrauch and Dr. W. Van Fleet were admitted to membership

The following papers were read

The Effect of Temperature on the Respiration of Fruits H C GORE

The rates of respiration were given of many fruits at different temperatures It was found that the forty different fruits studied obeyed approximately the same law in regard to the effect of temperature The rate of respiration increased two to three times for each 10° C rise, following van't Hoff's rule for increase in rate of chemical reactions with temperature The respiratory activity of the different fruits varied greatly and no correlation appeared between it and composition or size In general, fruits which grow and mature rapidly and soon become over ripe, respired rapidly, while fruits having a long growing season and maturing slowly were much less active

Collecting Grasses in Mexico A S HITCHCOCK

Mr Hitchcock described his recent trip to Mexico for the purpose of collecting and studying the grasses of that region He gave considerable attention in his paper, to the physiographic and climatic conditions and the relation of these conditions to the flora Tables and maps were submitted showing the topography of the country, and the monthly rainfall and temperature of several representative stations The speaker described the floral regions, the distribution of the grasses as affected by rainfall and altitude, and reviewed briefly the agricultural and range conditions, including the forage crops The paper was illustrated with about fifty lantern slides from photographs taken by himself and his son, Frank H Hitchcock, who accompanied him as assistant

The forty localities visited by Mr. Hitchcock included many type localities, which led to the rediscovery of certain little known or doubtful species of grasses described by earlier writers, among which species may be mentioned *Bouteloua repens* HBK, *Panicum decolorans* HBK, *P buchingeri* Fourn, *P. cordovense* Fourn and *P ischnanthoides* Fourn It is highly probable that Mr Hitchcock collected specimens from the same group of plants from which the types of the last two species were obtained On the other hand, species previously supposed to be restricted in range were found to be widely distributed *Panicum arizonicum* Scribn & Merr, known in Mexico only from the northwestern states, was collected as far south as the state of Oaxaca These facts emphasize the point that, when possible, the specialist should make his own collections

The Rediscovery of the Xochinacaztli of the Aztecs, with Notes on Mexican Anonaceæ. W. E. SAFFORD.

Before the conquest of Mexico the Aztecs used certain spices and aromatic plants in confectioning their celebrated chocolate The mostly highly prized by the ancient Mexicans was the flower called *teonacaztli*, or *xochinacaztli* ("sacred-ear" or "ear flower") Up to the present day the identity of this plant has remained a mystery The writer has finally succeeded in tracing it to *Cymbopetalum penduliflorum*, belonging to the Anonaceæ

Cymbopetalum penduliflorum (Dunal) Baillon was called *xochinacaztli* (ear flower) on account of the resemblance of its three inner petals to the human ear It occurs in the mountains of Guatemala and southern Mexico

Sapranthus fœtidus (Rose) Safford the fœtid carrion flower, is very closely allied to the palanco (*Sapranthus nicaraguensis*) of Central America. Another species, with flowers having an equally disgusting odor, but with broader petals and an orbicular bract on the peduncle, proves to be identical with the plant described by Dunal as *Unona violaceus*, and must therefore take the name *Sapranthus violaceus* (Dunal) Safford Specimens of it were collected by Dr J N Rose at Rosario, Sinaloa, in 1897 (No 1842)

Among the well known anonas are the sugar apple, *Anona squamosa*, usually called anona blanca in Mexico, *A reticulata*, the bullock's-heart, or anona colorado, *A cherimolia*, the Peruvian chirimoya, introduced at a very early date into Mexico, and the pleasantly acidulous fruited sour-sop, *A muricata*, usually known as Guanábana in tropical America

Anona purpurea DC, called soncollo, or sincuya, is a species often confused with *A muricata*, which it resembles in having large flowers with leathery petals and fruit covered with projecting points, but its flowers are sessile and its fruit is not edible, while its leaves differ from those of *A muricata* in being much broader and larger

Anona longiflora, usually called chirimoya, is very closely allied to *A cherimolia*. Its flowers, however, are much larger and its leaves, covered with velvety pubescence beneath, are broader and more obtuse It was first described by Sereno Watson from specimens collected by Dr Edward Palmer near Guadalajara in 1886

Anona diversifolia n sp. called izlama, or illamatzapotl, has flowers and fruit resembling those of *A. squamosa*, with the carpels not so closely united as in *A cherimolia*, and *A reticulata* It is distinguished from all other Mexican anonas by a large persistent orbicular, clasping bract at the base of the peduncle The type was collected by Dr Edward Palmer at Colima, Mexico, in 1897 (No 60)

W W STOCKBERGER,
Corresponding Secretary

THE PHILOSOPHICAL SOCIETY OF WASHINGTON

THE 689th meeting was held on February 11, 1911, President Day in the chair Two papers were read

Thermodynamics of Concentration Cells Dr HENRY S CARHART, of the University of Michigan

The paper was in illustration of the general equation expressing the laws of thermodynamics, of which the Helmholtz equation for the E M F of a voltaic cell is an example, viz

$$A = H + T(dA/dT),$$

in which H is the change in the internal energy of the system and A the maximum work or free energy for a reversible process conducted isothermally

A number of possible cases were outlined and two of them were emphasized for illustration and experimental verification

1 When H is constant Then $A = H + aT$ The relation is then linear and dA/dT is constant

2 If with Nernst ("Thermodynamics and Chemistry," *Sitzungsberichte der Kon Preuss Akad der Wiss*, 1909, 1, 247) it is assumed that H may be expressed in terms of the integral powers of T, then

$$H = H_0 + aT + bT^2 + cT^3 +$$

By integrating the general equation and substituting this value of H, it is proved that the constant a is zero and the two equations for A and H are

$$A = A_0 + a'T - bT^2 - \tfrac{1}{2}cT^3 -$$

$$H = H_0 + bT^2 + cT^3 +$$

Nernst assumes that $dA/dT = dH/dT = 0$ in the limit when $T = 0$ This condition would exclude the term $a'T$ and would exclude therefore the case where H is either zero or constant

An investigation of the concentration cell *Zn amal dilute/ZnSO$_4$ solution/Zn amal concen* gave the following data, which are best represented by the linear equation

$$E = -0\ 001455 + 0\ 00008084\ T\cdot$$

Temp	Obs'd E M F	Comp'd E M F	Per cent difference
11 1	0 007300	0 007307	+ 0 10
15 4	7444	7439	— 0 07
19 8	7574	7575	+ 0 01
24 6	7720	7723	+ 0 04
29 4	7870	7871	+ 0 01
32 8	7983	7976	— 0 09
36 6	8086	8094	+ 0 10
42 0	8262	8259	— 0 04
47 0	8417	8414	— 0 04

The greatest difference between the observed values and those computed by the above equation is 0 008 millivolt

The $ZnSO_4$ solution was then replaced by $ZnCl_2$ solution and the measurements were repeated. The results are best represented by the same equation within the limits of temperature 10° 1 and 49° 3 within which the observations were made Moreover, there is no break at the transition point of $ZnSO_4$ at 39° 0.

This relation is strictly linear and is directly and conclusively opposed to Nernst's assumption that the constant a and a' are both necessarily zero

Upon the Construction of the Wheatstone Bridge for Resistance Thermometers: Professor C F MARVIN, of the U S Weather Bureau

The speaker mentioned the well known fact that the resistance of metals such as platinum, nickel, etc, commonly employed in the construction of resistance thermometers, does not change with temperature according to a strictly linear law of relation, therefore, the scales of temperature obtained directly from resistance thermometers are not the same as the standard scale of temperature by the gas thermometer The object of the paper was to call attention to certain interesting mathematical relations between the bridge equations and those for platinum and nickel resistances, which, if availed of, enable the manufacturer to give the arms of the bridge such resistances that the indicated temperatures on the bridge scale correspond to the true temperature of the thermometer on the gas scale within a few hundredths of a degree over ordinary meteorological ranges of temperature, say from — 40° to + 60° Centigrade This result is obtained, moreover, when the subdivisions of the bridge scale are exactly equal throughout, and when the intervals of resistance on the bridge wire, or equivalent device, are made as exactly equal to each other as possible. Numerical data shown for nickel indicated that the logarithmic equation: $R = a + bt$ fitted the temperature resistance changes of some samples of nickel Other samples, however, require an equation of three terms, viz

$$\text{Log } R = a + bt - ct^2.$$

Diagrams and equations of bridges with the resistance placed in series with either the thermometer in the one case, or the balancing coil in the other, were explained

In all cases the bridge equations reduce to the general form $R = (A + Mt/N \pm t)$, in which A, M and N are constants fixing the numerical value of the resistances in the arms of the bridge The plus (+) sign applies when the shunted rheostat is in series with the balancing coil, and the equation then represents a curve, mathematically similar to a parabola, or a curve convex upward The equation with the minus (—) sign is required for the ordinary slide wire connections, and with the shunted rheostat in series with the thermometer In these cases the curve conforms very closely to the logarithmic or other curve *concave* upward

By computing the constants of the bridge equation from three points taken from the corresponding temperature resistance curve for the platinum or other thermometer that may be used, and then adjusting the resistances in the bridge accordingly, the indicated temperatures on the bridge are either identical with the gas-scale temperatures, or differ therefrom by only a few hundredths of a degree at the extremities of the range of eighty to one hundred degrees

Numerical examples were worked out and the resistances computed for the arms of the bridge to fit a platinum and a nickel thermometer. It was mentioned in the discussion that all of the equations apply equally to the case in which the differential galvanometer is employed instead of the bridge to determine the resistance of the thermometer

It is expected that this paper in full will be published in the *Journal of the Franklin Institute*

(The abstracts of the two foregoing papers are by their authors)

Professor Cleveland Abbe, of the U. S Weather Bureau, spoke informally concerning the altitude of the aurora, describing briefly Professor Störmer's recent successful method of measuring the altitude of an aurora, which consists essentially in simultaneously photographing the aurora from two points of known distance apart, some known star being also simultaneously photographed on the plates from which measurements can be made

R. L. FARIS,
Secretary

SCIENCE

Friday, March 31, 1911

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MSS. intended for publication and books, etc., intended for review should be sent to the Editor of Science, Garrison-on-Hudson, N. Y.

THE BEGINNINGS OF INTELLIGENCE[1]

Nothing shews more the force of habit in reconciling us to any phenomenon, than this, that men are not astonish'd at the operations of their own reason, at the same time, that they admire the *instinct* of animals, and find a difficulty in explaining it, merely because it can not be reduc'd to the very same principles. To consider the matter aright, reason is nothing but a wonderful and unintelligible instinct in our souls, which carries us along a train of ideas, and endows them with particular qualities, according to their particular situations and relations.—David Hume, "Treatise on Human Nature."

We all have a certain curiosity regarding the evolutionary history of our various powers and attributes, but from many points of view an unusual interest attaches to the first development of intelligence. The word intelligence is used in a variety of senses by writers on comparative psychology and any discussion of the origin of intelligence would be fruitless unless the meaning in which the term is employed be understood. One of the foremost of comparative psychologists, the acute Father Wasmann, defines intelligence as "the power of conceiving the relation of concepts to one another and of drawing conclusions therefrom. It involves abstraction, deliberation and self-conscious activity." Intelligence, according to Wasmann, is the God-given attribute of man alone; its possession separates man from brute by an impassable barrier.

Many comparative psychologists, among whom we may mention Lloyd Morgan, Forel and Loeb, adopt as a criterion of intelligence the power of forming asso-

[1] Read before the meeting of the Sigma Xi of the University of California, December 7, 1910.

ciations, or associative memory, and we shall follow the usage of these writers. It is obvious that the possession of this faculty marks an important step in advance upon the creatures whose actions are fatally determined by their instinctive make-up. From its beginning in forms in which the simplest associations are established only after a large number of experiences, intelligence has assumed a rôle of ever-increasing importance in the evolution of animal life, until in man, who is notoriously a weakling compared with the large beasts with which he has had to contend it became the main factor to which the human species owes its supremacy in the struggle for existence

In considering the origin of intelligence one is naturally led to the subject of the relation of intelligence to instinct Formerly it was the custom to contrast these two faculties as if they represented diametrically opposed types of activity Instinct was regarded as something unalterably fixed, machine-like and practically perfect in its adaptation to the needs of the animal, intelligence was recognized as the antithesis of all these qualities—variable, plastic and eminently fallible. With the establishment of the theory of evolution writers became more disposed to discover the kinship and filiation of instinct and intelligence and they have given us a variety of views as to the relation of these faculties

Basing his theory on Lamarck's doctrine that instinct is inherited habit, G H Lewes attempted to explain instinct as "lapsed intelligence" Performances which are learned with difficulty come, after sufficient repetition, to be carried out automatically and without any intelligent guidance If the acquired facility of performing these acts is inherited and the acts are repeated generation after generation, it is probable that they might finally be performed by an individual without any previous instruction at all, that is, they would become instinctive. An animal's instincts, according to this view, represent the stereotyped and mechanized behavior which its ancestors found to be profitable; their adaptiveness rests upon the wisdom acquired by ancestral experience More recently this view has been upheld by Eimer, and in a less extreme form by Romanes, Wundt and many others

One difficulty with the theory of lapsed intelligence is that it involves the acceptance of the doctrine of the transmission of acquired characters, which has come to be a very questionable biological theory. But another and more fundamental difficulty is revealed by recent work on the behavior of lower organisms If instinct were derived from intelligence by a sort of mechanizing process we should expect, as Whitman has urged in his criticism of Lewes's theory, to find intelligence dominant in lower forms of life, and that acts which are instinctive in the higher animals would be intelligently performed by the lower ones The work that has been done on the behavior of lower organisms enables us to state with confidence that such is not the case. In several large phyla of the lower invertebrates there has not, as yet, been demonstrated the least glimmer of intelligence; and, as we pass up the scale of life, intelligence gradually supersedes instinct, not the reverse We can say with some degree of assurance that, however the transition may have been effected, intelligence has grown out of purely instinctive behavior

It is not possible, however, to fix, except with the rudest approximation, the stage of evolution at which intelligence makes its first appearance The transition from instinct to intelligence has been made in all probability, not once, merely, but several

times along different lines of descent. Intelligence in the vertebrates doubtless arose independently from that of the insects, and the intelligence exhibited here and there among the mollusks probably arose independently along a third line of development. Intelligence makes its appearance at a certain stage of organization along whatever line such a stage may have been reached.

Up to the point at which the power of associative memory becomes manifest there has been progress along many lines which has prepared the way for the evolution of this new faculty Behavior has not only become more complex, but it has become more plastic and capable of easy modification to suit new conditions The lower organisms do not always react in a particular way to a given stimulus What reaction occurs may depend upon the number of previous stimulations, the supply of food, exposure to different environing conditions, and numerous other factors which influence the internal state of the organism The behavior of many lower animals is plastic and adaptive to a remarkable degree, and to a superficial consideration often gives the appearance of a considerable degree of intelligence, without there being any detectable power of associative memory This plastic and varied behavior not only simulates intelligence, but it secures for the organisms many of the advantages which intelligence confers It adapts the animal to a more varied environment, and gives it the power of meeting a given situation in more than one way, so if one kind of response does not suit, another may be more successful Let us glance briefly at some of the ways in which behavior may be modified.

A very general change of behavior in its organisms consists in the habituation to any stimulus which is repeated at sufficiently close intervals so that the organism no longer responds to it This is shown even among the protozoa A *Stentor* or a *Loxophyllum* subjected to a light mechanical stimulus at short intervals soon fails to respond as at first, but the duration of the modification so produced is very short, in *Loxophyllum* it probably does not extend over two or three seconds Similar effects of repeated stimulation but of longer duration have been observed in *Hydra*, several species of sea-anemones, planarians, annelids and various other lower invertebrates As a rule failure to respond may occur more quickly and the effects of the stimulus remain longer as we pass up the scale of animal life

Occasionally the reverse phenomenon occurs when the response to a given stimulus is increased instead of diminished with repeated applications—a result which suggests the effect of the summation of stimuli At times, as Bohn found in *Cerianthus*, there is an initial increase of responsiveness followed by a dulling of sensitivity Bohn has attempted to subsume the effects of repeated stimulation under a general "law" to the effect that stimulation always produces at first increase of sensitivity to be followed later by a decrease Sometimes, as Bohn claims, the initial increase is so short as to escape detection, which may be true, but the burden of proof is on M Bohn

Repetition of a stimulus may call forth not only quantitative differences of response, but it may evoke responses of very different character. Animals are frequently provided with several modes of reacting to a given stimulus which may be called into play one after the other Jennings has shown that if a *Stentor* is subjected to a light mechanical stimulus by causing fine particles of India ink to fall upon its disk from a capillary pipette it

usually reacts first by bending a little to one side. If the particles continue to fall on the disk the beat of the cilia covering the body may suddenly be reversed, thus creating a current tending to carry the offending particles away. If in spite of this the particles still impinge upon the disk the *Stentor* may contract one or more times. Finally, if all these reactions are tried in vain the infusorian may give a number of violent contractions, break loose from its place of attachment, and swim away.

It would be an error to interpret the varied behavior of this unicellular organism as a manifestation of intelligence, although it is not unlike what the behavior of an intelligent creature might be under the circumstances. No power of learning by experience has ever been discovered in *Stentor*, or indeed in any other protozoan. The organism is provided with a number of different modes of response, and which one is set in action depends upon internal factors which are influenced by the creature's previous activity. The organism which has responded to a stimulus has become transformed into a different mechanism which may respond more or less readily than before or radically change its method of behavior.

A striking illustration of varied responses to a given stimulus has been described by Jennings in the sea anemone *Stoichactis*. If a foreign body is placed upon its disk the anemone tries to rid itself of the object in various ways. The tentacles near the object collapse and the area between them extends, thus producing a relatively smooth surface so that the waves can readily wash the object away. If this does not occur the region under the object begins to swell, thus rendering the removal of the object still easier. If this reaction is unsuccessful the edge of the disk begins to sink so that a smooth sloping surface is formed from which the object can readily slide. Here, as in the case of *Stentor*, we have an organism capable of reacting in several ways to a given stimulus. What particular reaction is evoked depends upon previous stimulations.

Modification of behavior caused by different conditions of nutrition are found in the lowest members of the animal kingdom. Even the white blood cells after they have ingested a number of bacteria refuse to take in more. Whether there is a limit to the appetite of *Amœba* has not been determined, but many infusorians such as *Stentor*, after having swept in a certain amount of food, react to food particles in a quite different way than when in a hungry condition. *Hydra* when not fed for some time extends the body, sways about in various directions and keeps up a restless movement of its tentacles, thereby increasing its chances of contact with the small creatures which serve as its prey.

Instances of the non-intelligent modifications of behavior might be multiplied indefinitely. As we pass to higher forms the capacity for responding in different ways to a given situation becomes greatly increased. "Nature," says James in his admirable chapter on instinct, "implants contrary impulses to act in many classes of things, and leaves it to slight alterations of the conditions of the individual case to decide which impulse shall carry the day;" and he points out that many animals lose the instinctive demeanor and appear to lead a life of hesitation and choice, not because they have no instincts, but because they have so many of them that they block one another's path. Intelligence in the acceptation of the term which we have accepted begins with the formation of associations. It does not make its appearance, so far as is known, until a comparatively

high stage of organization has been attained The evolution along the lines of complexity of instinct and ready modifiability of reactions to suit new conditions, affords a substantial basis for intelligent behavior. Without such evolution the power of associative memory would avail little But with a large number of readily modifiable instincts, associative memory becomes the means of affording a much wider and closer adjustment to the environment

The studies which have been made of primitive types of intelligence such as found in crustaceans, fishes and amphibians have shown that associations are formed by a gradual process of reinforcement or inhibition of a particular reaction to a given stimulus The method followed is one which Lloyd Morgan has designated as "trial and error" It may be illustrated by the experiment of Yerkes on the formation of associations in the crayfish. In these experiments a box was employed into one end of which the crayfish was admitted through a narrow aperture The other end of the box was divided by a median partition which gave the crayfish a choice of two routes to a tank of water at the other end into which the creature was naturally desirous of getting One of the two ways to the water was closed by a glass plate at its farther end so that the crayfish was afforded a choice of a right and a wrong path to the water. Would the crayfish after a number of trials learn to choose the right path and avoid the closed passage? In the first ten experiments the crayfish went as often to the right as it did to the left, but in the next ten trials the percentage of correct choices was somewhat greater. Finally after a large number of trials the animal came to choose the right path to the water, making but rarely any mistakes

Similar experiments with crabs, fishes and the frog have yielded similar indications of slow learning. In some respects such learning resembles the slow formation of a habit rather than the judgment of a consciousness which "sizes up" the situation and determines upon a certain course of action. It is quite probable that such a primitive form of learning does not include any association of ideas It can be satisfactorily accounted for by assuming nothing more than an association of certain sense perceptions with particular movements The animal may have no ideas to associate—nothing but sense impressions and motor impulses Of course its mental content *may* include much more than this, but in interpreting the behavior of animals it is generally advantageous to follow the principle laid down by Lloyd Morgan—which is a sort of special application of the law of parsimony—that we should not assume the existence of a higher psychic function if the phenomena can be explained as well in terms of a lower one.

The step from sensori-motor association to the association of ideas is not, I believe, a wide one, and comes abont as a natural consequence of the elaborateness and what Hobhouse has designated as the "articulateness" of the mental process of adjustment It is foreign to our purpose, however, to trace the increase in the number, delicacy, quickness and complexity of the processes of association which we meet in the various stages of mental evolution One problem at present lies in the initial step involved in the formation of a simple association And it is a problem which, despite its apparent simplicity, involves the consideration of some vexed and subtle questions.

In learning we have to do with two opposite processes of reinforcement and inhibition. A chick after it pecks at a caterpillar which is wholesome and savory pecks

at a similar caterpillar more readily on a second occasion. Something has apparently reinforced the connection between the visual impression produced by the caterpillar and the pecking impulse. If, on the other hand, the chick pecks at a caterpillar having a nasty taste it is apt to avoid pecking at it a second time. Something has happened to inhibit the response that would otherwise occur. We commonly explain such behavior by ascribing to the creature feelings of pleasure and pain. We say that the chick pecks at one kind of a caterpillar because of the pleasant taste it derives, and avoids another variety because its taste is bad. Pleasure and pain apparently function as agents for the reinforcement of certain reactions and the stamping out of others. It is a general rule, though not without certain exceptions, that what affords pleasure is conducive to organic welfare, while that which is productive of pain is injurious. The upshot is that the associations that are the outcome of the pleasure-pain response are of just the kind that minister to the animals' needs. Beneficent arrangement! Apparently we have to do with a selective agency which preserves and intensifies certain kinds of behavior and rejects others on the basis of their results—a kind of "sorting demon" in the realm of behavior. What could be more teleological!

The fact that what is pleasant is usually beneficial and what is painful is usually injurious may be explained with some plausibility as the result of natural selection, as was first contended by Herbert Spencer. Animals which took pleasure in doing things which were bad for them and which experienced pain in doing things which were good for them would be very apt to fare ill in the struggle for existence. Natural selection would ever tend to bring about a condition in which the pleasant means the organically good and the painful means the reverse. We should not expect the correspondence, if brought about in this way, to be complete, and it is rather in favor of the theory that we do not find it so.

But granting this contention of Spencer, there is the important question still left unanswered, namely, Why do animals follow what is pleasant and avoid what is painful? In other words, why does pleasure reinforce and why does pain inhibit? Here is another fundamental problem and we find that Spencer with his usual appreciation of fundamental problems was on the ground early with a theory. Pleasure, according to Spencer, is the concomitant of a heightened nervous discharge, pain the concomitant of a lessened nervous discharge. An act which brings pleasure causes an influx of nervous energy to the centers concerned in the movement, the lines of discharge become "more permeable," and upon a repetition of the conditions the same act follows with greater readiness than before. If the act is followed by pain with its concomitant of lessened nervous discharge, the diminution of nervous energy serves to prevent the performance of the act in response to the same conditions. Closely similar explanations of the physiology of the pleasure-pain response have been given by Bain and by Baldwin, the latter declaring that "pleasure and pain can be agents of accommodation and development only if the one, pleasure, carry with it the phenomenon of motor excess—and the other, pain, the reverse—probably some form of inhibition or of antagonistic contraction."

The physiological concomitants of pleasure and pain have afforded a subject for numerous laboratory studies and almost no end of theories. It has been impossible thus far to discover that either of these states is invariably accompanied by any

definite physiological condition The theory of Spencer and Bain is open to obvious criticism, for the man who steps on a tack undoubtedly has a "heightened nervous discharge," as much as a man who shouts for joy And I believe I am safe in saying that no theory of the physiology of pleasure and pain is on a sufficiently firm basis to warrant its being regarded as anything more than a very tentative working hypothesis

With our present knowledge of the psycho-physiology of pleasure and pain, the attempt to explain how these states or their physiological concomitants, whatever they may be, can act as agents of reinforcement and inhibition seems rather a fruitless one The process which we meet at the beginning of intelligence in simple associative memory may be formulated as follows

stimulus — reaction — pleasure — reinforcement
physiological state x
stimulus — reaction — pain — inhibition
physiological state y

Spencer, Bain and others have endeavored to show how the organic accompaniments of pleasure and pains modify the creatures' subsequent responses But as the problem was interrupted by these writers our ignorance concerning the physiological states x and y brings us to a standstill.

In his valuable work on "Mind in Evolution" Hobhouse has presented a new point of view in considering this problem, which has the advantage of not involving any general theory of the physiology of pleasure and pain It is essentially a theory of how behavior comes to be adaptively modified through the formation of associations It makes no attempt to explain why pleasure is associated with certain experiences and pain with others. Such association may turn out to be as inexplicable as the problem why stimulation of the optic nerve gives rise to a sensation of light instead of some other kind of feeling What it is feasible to attempt to explain is why certain responses tend to be repeated and others tend to be inhibited And this can be explained with some plausibility as due to the congruity or incongruity of the reactions which come to be associated For the sake of illustration let us consider again the chick which pecks at a nasty caterpillar The irritation set up by the caterpillar in the chick's mouth evokes movements of withdrawal and ejection The two responses of pecking and ejection become associated, but as the two movements are contradictory the result is inhibition The pecking reaction no longer occurs in the presence of a second nasty caterpillar, not because of any stamping-out influence of the physiological concomitant of pain, but because it becomes joined with an antagonistic reaction

In a previous paper by the writer the attempt was made to extend the theory of Hobhouse to account for the reinforcement commonly held to be caused by pleasure. The assumption was made that this process is due to an organic congruity of the reactions If the caterpillar pecked at is a savory one there is set up the reflex of swallowing Pecking and swallowing form the normal elements of a chain reflex, when one part of the structure concerned is excited it tends to increase the tonus of the associated parts, and thus reinforce the original response I have found that in the crayfish stimulation of the antennules, which are important organs of smell, sets up chewing movements of the mouth parts and grasping movements of the small chelæ Similarly stimulating the small chelæ evokes chewing movements of the mouth parts and twitching of the antennules, while stimulating the mouth parts

directly may cause movements in both the other sets of organs. We have here as a matter of fact a number of reflexes which mutually reinforce one another. Suppose that in the chick the sight-pecking response and the taste-swallowing response are related as the feeding reflexes demonstrably are in the crayfish, the second response would thus tend to reinforce the first, and if this tendency persisted we would have a case of learning by experience

Animals in the course of their instinctive responses encounter stimuli which bring about other responses These become associated According to the nature of the nervous pathways involved, there may be reinforcement of or interference with the original reaction Experience brings about an extension of the range of adaptations by the assimilation of congruent reactions and the elimination of acts whose secondary consequences are in the nature of antagonistic and thereby inhibitory responses Such we may say, by way of expressing a tentative view-point, is the nature of primitive intelligence

But it will be seen that the capacity to form new adaptations rests upon the primary adaptiveness of the instinctive reactions. The power of formation of associations alone would never lead to improvement The adaptiveness of intelligence is based upon the adaptiveness of instinct, it may be said that intelligence is a means of enabling an animal to live its life more completely and successfully, but instinct furnishes the fundamental springs of action Even complex creatures like ourselves form no exception to this rule.

S. J. HOLMES

UNIVERSITY OF WISCONSIN

THE GALTON CHAIR OF EUGENICS

WE have noted that Sir Francis Galton, F.R.S., who died on January 17, aged 88, had left his residuary estate to the University of London for work in eugenics This residuary estate will amount to about £45,000 In his will Sir Francis Galton describes the scope of his new foundation as follows

I devise and bequeath all the residue of my estate and effects, both real and personal, unto the University of London for the establishment and endowment of a professorship at the said university to be known as "The Galton Professorship of Eugenics," with a laboratory or office and library attached thereto And I declare that the duty of the professor shall be to pursue the study and further the knowledge of national eugenics—that is, of the agencies under social control that may improve or impair the racial faculties of future generations physically and mentally And for this purpose I desire that the university shall, out of the income of the above endowment, provide the salaries of the professor and of such assistants as the senate may think necessary, and that the professor shall do the following acts and things, namely

1 Collect materials bearing on eugenics

2 Discuss such materials and draw conclusions

3 Form a central office to provide information, under appropriate restrictions, to private individuals and to public authorities concerning the laws of inheritance in man, and to urge the conclusions as to social conduct which follow from such laws

4 Extend the knowledge of eugenics by all or any of the following means, namely (*a*) professorial instruction, (*b*) occasional publications; (*c*) occasional public lectures, (*d*) experimental or observational work which may throw light on eugenic problems

He shall also submit from time to time reports of the work done to the authorities of the said university.

I also declare that the said university shall be at liberty to apply either the capital or income of the said moneys for any of the purposes aforesaid, but it is my hope that the university will see fit to preserve the capital thereof wholly or almost wholly intact, not encroaching materially upon it for cost of building, fittings or library Also that the university will supply the laboratory or office at such place as its senate shall from time to time determine, but preferably in the first instance in proximity to the Biometric Laboratory. I state these hopes on the chance of their having a moral effect upon the future decisions of the senate of the university, but they are not intended to have

any legally binding effect whatever upon the freedom of their action. And I declare that it shall be lawful for the senate of the said university, if they shall think fit so to do, to postpone the election of the first or any subsequent professor of eugenics for a period of not exceeding four years from the date of my death, or from the date of the occurrence of any vacancy in the office as the case may be . .

I declare it to be my wish, but I do not impose it as an obligation, that on the appointment of the first professor the post shall be offered to Professor Karl Pearson, and on such conditions as will give him liberty to continue his Biometric Laboratory now established at University College

SCIENTIFIC NOTES AND NEWS

THE National Academy of Sciences will hold its annual meeting in Washington, beginning on Tuesday, April 18

THE American Philosophical Society will hold its general meeting in the hall of the society at Philadelphia on April 20, 21 and 22 On the evening of April 21, Professor Svante Arrhenius, of Stockholm, will give an illustrated lecture on the physical condition of the planet Mars, which will be followed by a reception in the hall of the College of Physicians. On the evening of the twenty-third the annual dinner of the society will take place at the Bellevue-Stratford

DR WILLIAM H WELCH, professor of pathology in the Johns Hopkins University, has received from the emperor of Germany the decoration of the royal crown of Prussia, second class.

DR. LEWIS BOSS, director of the Dudley Observatory and of the department of meridian astronomy of the Carnegie Institution, has been elected a corresponding member of the Academy of Sciences of St. Petersburg

DR. S. W. STRATTON, director of the Bureau of Standards, represents the United States government at the International Convention on Weights and Measures at Paris, beginning on March 29.

PROFESSOR ALBERT A. MICHELSON, head of the department of physics in the University of Chicago, will give a course at the University of Gottingen in the coming summer semester.

AT the invitation of the Department of Education of the Philippine government, Professor J Paul Goode, representing the University of Chicago, will deliver a series of lectures to the Teachers' Assembly at Bagino in May

THE expedition that was sent to Argentina two years and a half ago under the auspices of the Carnegie Institution for the purpose of making meridian measurements of position of stars down to the seventh magnitude that are south of $-20°$ of declination, and generally inaccessible for exact measurement at observatories of the northern hemisphere, has completed its meridian-work In 1909 and 1910 about 87,000 meridian-determinations of positions were made with precision The observations were conducted on a fundamental basis, and correspond to others to be secured at the Dudley Observatory at Albany as an integral part of the entire enterprise The instruments were shipped to Albany from Buenos Aires early in March and the members of the staff, of which Professor Richard H. Tucker is director, are arriving at various times

THE magnetic survey yacht the *Carnegie* arrived at Capetown on March 20, having completed successfully a voyage of about 14,000 miles in the Atlantic Ocean since last June Dr Bauer left Vancouver on March 24 to make magnetic observations in the Samoan Islands during the total solar eclipse of April 28 and to meet the *Carnegie* at Colombo, Ceylon

IT is stated in *Nature* that at the recent meeting of the Australasian Association for the Advancement of Science in Sydney, the Mueller memorial medal was awarded to Mr. Robert Etheridge, curator of the Australian Museum, in recognition of the value of his numerous contributions to the paleontology and ethnology of Australasia.

THE trustees of Dartmouth College have voted that Charles Henry Hitchcock be made Hall professor of geology, emeritus, and that Gabriel Campbell be made Stone professor of

intellectual and moral philosophy, emeritus. They retired last year on the Carnegie Foundation fund. Frank Asbury Sherman, professor of mathematics, will retire at the end of the academic year, when he will have reached the age of sixty-nine years.

PROFESSOR BERNSTEIN, director of the physiological laboratory at Halle, will retire from active service at the beginning of the winter semester on account of advanced age.

DR. ROLLIN T. CHAMBERLIN, of the University of Chicago, sailed for South America on March 20, to engage in geological work on some of the metamorphic rocks of southeastern Brazil and on certain portions of the Andes.

DR. SIMON B. WOLBACH, assistant professor of bacteriology at the Harvard Medical School, and Dr. J. L. Todd, of McGill University, have departed for West Africa to study the sleeping sickness and allied diseases.

DR. A. S. PEARSE will leave the University of Michigan on April 1, to fill a position as assistant professor in the department of zoology of the University of the Philippines in Manila.

DR. ÖSTEN BERGSTRAND, for some time observer at the Upsala Observatory, Sweden, has been appointed professor of astronomy in the Upsala University and director of the observatory.

DR. SVANTE ARRHENIUS, director of the Nobel Institute, Stockholm, lectured before the Washington Academy of Sciences and the Philosophical Society of Washington on March 25 on "The Siderial Cultus."

DEAN ALLEN J. SMITH, of the University of Pennsylvania, closed a series of popular health lectures, given under the auspices of the medical faculty, March 17. His talk was on "Flies and Other Insects as Carriers of Disease."

ON the evening of March 17, Professor C. J. Keyser, of Columbia University, delivered a lecture before the Philosophical Club of Princeton University on "The Nature and Philosophic Significance of the Mathematical Doctrine of Invariance."

MR. JAMES R. STEERS, of the class of 1853, has made a further gift of $2,200 to the Wolcott Gibbs Library of Chemistry of the College of the City of New York. The money is to be expended in the completion of certain journals and for cataloguing.

A PORTRAIT of David Rittenhouse, painted in 1772 by Rembrandt Peale, has been given to the University of Pennsylvania by Mrs. William Lawber. David Rittenhouse was professor of astronomy and vice-provost of the university from 1779 to 1782, and from 1782 until the time of his death in 1796, a trustee.

FÉLIX PLATEAU, who recently retired from active duties of the chair of zoology in the University of Genth, known especially for his studies on the behavior of insects, died on March 4.

IN the New York senate on March 21 a bill was introduced to incorporate "The Carnegie Corporation of New York." The incorporators named in the bill are Andrew Carnegie, Senator Elihu Root, president of the Carnegie Endowment for International Peace, Dr. Henry S. Pritchett, president of the Carnegie Foundation for the Advancement of Teaching, William H. Frew, president of the board of trustees of the Carnegie Institute of Pittsburgh, Robert S. Woodward, president of the Carnegie Institution of Washington, Charles L. Taylor, president of the Carnegie Hero Fund Commission; Robert A. Franks, president of the Home Trust Company, and James Bertram, Mr. Carnegie's secretary. Under the language of the bill the incorporators are authorized "to receive and maintain a fund and apply the income to promote the advancement and diffusion of knowledge among the people of the United States, by aiding technical schools, institutions of higher learning, libraries, scientific research, hero funds, useful publications, and by such other agencies and means as shall from time to time be found appropriate."

THE Austrian Academy of Sciences held on March 9 a sitting to celebrate the fiftieth anniversary of the appointment of the Archduke Rainer to be its curator. The archduke gave 100,000 kronen to the academy as an en-

dowment to keep the academy in touch with the progress of science abroad

M FAUVEL has offered 30,000 francs for the construction of an addition to the laboratory of the National Museum of Natural History in Paris

THE president of the Royal Society and the members of the General Board of the National Physical Laboratory visited the laboratory on March 17

AT midnight on March 10 the clocks at the railway stations and all government offices and municipal buildings of France and Algeria were set back nine minutes twenty-one seconds, to bring them in accord with Greenwich time, which is now used in all countries of western Europe except Russia, Portugal and Ireland

THE ninth International Congress of Agriculture will be held at Madrid, beginning on May 8, under the patronage of his Majesty Alfonzo XIII Americans wishing to attend the congress may secure the printed account of the arrangements from the American member of the *Commission Internationale d'Agriculture*, Dr L O Howard, U S Department of Agriculture, Washington, D C

THE next triennial prize of £300, under the will of the late Sir Astley P Cooper, will be awarded to the author of the best essay or treatise on "The Means by which the Coagulability of the Blood may be Altered" Essays, written in English, must be sent to Guy's Hospital, before January 1, 1913

THE U S Civil Service Commission announces an examination on April 15, to fill at least three vacancies in the position of magnetic observer in the Coast and Geodetic Survey The initial salaries will range from $75 to $90 a month, according to the character of the work and the qualifications of the applicant; and in exceptional cases where the person employed has had repeated experience in magnetic work, the initial salary may reach $125 a month. Appointments to permanent positions are also made from the examination for laboratory assistant in the Bureau of Standards

THE Harpswell Laboratory will be open this summer for the fourteenth season, from June 19 to September 15 South Harpswell is 16 miles from Portland, Maine, with which it is connected by several boats daily The location is admirably adapted for a biological station It has a very rich marine flora and fauna Especially noteworthy are the abundance of Elasmobranch material, and the eggs of *Cerebratulus* and *Echinarachnius*, so valuable for experimental studies For several years the laboratory has been open solely for research, no instruction being given It has nine private rooms, several of which are already engaged for the coming summer, and can accommodate a few more in the large laboratory room Thanks to the cooperation of several colleges and universities, the laboratory is able to offer its facilities free to those competent to carry on independent investigation There will be a collector employed and the laboratory has several boats, including a motor boat, dredges, the usual instruments and glass ware and a little physiological apparatus Alcohol for collections and expensive chemicals can not be furnished There is also a small library The laboratory will not issue a circular this year Those wishing to avail themselves of its facilities should apply to Professor J S Kingsley, Tufts College, Mass It would be well to give some idea of the line of work to be followed so that advice may be given as to the prospects of material

BY cooperation between the American Museum of Natural History and the United States Bureau of Fisheries, the government steamer *Albatross* sailed from San Diego, on February 25, on a two months' collecting expedition to Lower California Dr. Charles H. Townsend, acting director of the museum, is in command of the expedition He is accompanied by seven investigators and collectors, representing the U. S National Museum, the New York Zoological Society and the New York Botanical Gardens, all of which bear a share of the expense of the trip Dr Townsend began the work with a line of deep-sea dredgings to Guadalupe Island, some two

hundred and fifty miles from San Diego From Guadalupe Island the *Albatross* planned to work eastward to begin a fish survey of the peninsula of Lower California. The fishery resources of the region will be studied with a view to the establishment of closer fishery relations with Mexico There will be work on shore also The peninsula is seven hundred and fifty miles long and will be studied along both coasts During the progress of the vessel along these coasts collecting parties will be landed each day to procure the mammals, birds, reptiles and fishes of the region, which are of especial interest to naturalists because so large a number of them are peculiar to the locality

THE Charleston (S. C) Museum has been developing a large amount of public interest recently in the scientific studies that were so much cultivated in that city in the years before the war In the middle decades of the last century, Charleston was a center of scientific work and interest The visit there of Agassiz in 1850, and the notable work of Audubon and Bachman, and of others beside, gave great stimulus to scientific pursuits There has been organized in recent years a Natural History Society, as an educational department of the museum, composed largely of young people, but by no means confined to them, which has already done much excellent local work, and is raising up and training a body of enthusiastic observers, especially in botany and ornithology The museum has also within the past year issued the first volume of its "Contributions,"—"The Birds of South Carolina," by Arthur Trezevant Wayne, honorary curator of ornithology in the museum, and a recognized authority on the birds of the region This is an octavo volume of 254 pages, and is the most complete and accurate work on the subject that has been published With a view to stimulating public interest, and also in the desire to link the present and future work of the museum with that which gave Charleston its reputation in the days of Audubon and Bachman, the Natural History Society proposed to devote its March meeting to the work of those eminent men, and to make it a memorial occasion To this end, request was made for copies in private hands, of the plates and various editions of their works, and also for other objects connected with them The main hall of the museum was assigned to this Audubon-Bachman exhibit The result exceeded all anticipation, and revealed a wealth of choice material of this kind, belonging to private owners that had not been suspected A noble collection of Audubon's bird-plates was thus secured, together with copies of the several editions of his work on birds, and of the joint work of Dr. Bachman on the mammals, with busts, portraits, original drawings, etc., of great interest This loan collection attracted much public attention, and has given a distinct impetus to scientific appreciation in the city At the memorial meeting, held on March 2, a large audience was present, and very interesting addresses were given on the life and work of both Audubon and Bachman, by several speakers, including Director Rea, of the Museum, and the venerable Dr C S Vedder, of Charleston, an intimate friend of Dr Bachman for many years

A NEW expedition is being arranged, Reuter's Agency learns, to explore the Snow Mountains of New Guinea, a region in which the British expedition under Captain Rawling is at present working The Dutch government is interested in the undertaking, and Queen Wilhelmina and Prince Henry have contributed towards the cost. The details have not yet been finally arranged, but it is probable that Captain von Nauhuys, who has already been on three expeditions in New Guinea under Dr. Lorentz, will be in command and will be accompanied by a number of European scientific men.

THE production of tungsten in the United States increased considerably during the year 1909, but practically all the nickel, cobalt and tin consumed was imported. In an advance chapter from "Mineral Resources of the United States Calendar Year 1909," prepared by Frank L. Hess for the United States Geological Survey, the production of these metals and of the rarer metals vanadium, titanium,

molybdenum, uranium and tantalum is reported. Colorado led in the production of tungsten in 1909 The prices quoted for the metal were considerably higher than in 1908, and the production of ore increased from 671 short tons, valued at $229,955, to 1,619 tons, valued at $614,870. This is the largest quantity produced by any country in one year The United States last year produced nearly one third of the world's total production of tungsten ore, which was about 5,300 tons Very little nickel was produced in the United States, but a great deal was imported, and, as more nickel is refined in this country than can be used here, large quantities were exported In all, 22,194,102 pounds of nickel as metal and as metallic content of ores were brought into the United States in 1909 The total value was $3,036,273 The exports of nickel amounted to 12,048,737 pounds, valued at $4,101,976 The importations of cobalt amounted to 12,132 pounds, valued at $11,696 Titanium is being used with great success in making steel rails The New York Central Line has given rails treated with ferrotitanium a thorough test in the Grand Central terminal yards and now requires that all rails made for its lines shall be treated with titanium alloy. Rutile, or titanium oxide, was produced in the United States last year only at and near Roseland, Va No rutile was imported, but one American company exported it in considerable quantities Molybdenum, uranium and tantalum were little used in the United States in 1909, and only a small quantity of tantalum was produced A little was imported from Germany, but the use of tungsten in incandescent lamps has proved so satisfactory that the demand for tantalum has probably not greatly increased Although the United States uses 43 per cent. of the world's output of tin, it is not an important producer of that metal. Tin was produced in Alaska and South Dakota in 1909, but not in large quantities. In 1909 there were imported into the United States 47,662 tons of tin, valued at $27,558,546. The average price was 28.91 cents a pound. Several thousand tons of tin are recovered from used tin cans and other wastes.

UNIVERSITY AND EDUCATIONAL NEWS

THE subscription to the memorial to President Grover Cleveland exceeded $100,000 on the seventy-fourth anniversary of his birth It will be remembered that the memorial is to be a tower forming part of the graduate college of Princeton University

THE University of Washington at Seattle has received from Messrs Sigmund and Abraham Schwabacher $30,000 to maintain a bureau of child welfare

GOVERNOR STUBBS, of Kansas, has vetoed the bill placing the University of Kansas and other state institutions under the control of a commission consisting of three paid members It is stated that the recent legislature seriously reduced the appropriations for the university

THE University of the Pacific, College Park, California, by the action of its trustees, will henceforth be known as the College of the Pacific This action separates the college from a conservatory of music and a preparatory department.

AT the meeting of the board of regents of the University of Minnesota on March 3, the salary of one of the professors, who is dean of one of the schools, was increased from $4,000 to $6,000

THE cornerstone of the administration building of the William M Rice Institute, was laid by the trustees on March 2, the seventy-fifth anniversary of Texan independence The seven members of the board were present. They are: J. A Baker, W. M. Rice, Jr., J. E McAshan, B. B Rice, C. Lombardi, E. Raphael, E O Lovett.

HEREAFTER the degree of bachelor of chemistry (B Chem.) will be conferred by Cornell University on students who have completed the special course in chemistry The department of chemistry remains a department of the College of Arts and Sciences. A four-year course in chemistry and allied subjects has been offered by the department since about 1903 for students planning to follow chemistry as a profession. Although the course is essentially technical in character and professional in purpose, the degree of bachelor

of arts, has heretofore been conferred upon its graduates

AT Smith College Harriet W Bigelow has been promoted to be professor of astronomy, and Frances Grace Smith to be associate professor of botany

AT Yale University Dr Alexander Petrunkevitch has been promoted to be assistant professor of zoology, and Dr Carl Johns, to be assistant professor of chemistry

DISCUSSION AND CORRESPONDENCE

THE AIR WE BREATHE

TO THE EDITOR OF SCIENCE As a member of the American Society of Heating and Ventilating Engineers, who had the pleasure of hearing the recent address of Dr. Gulick before that society, I desire to reply to his letter in SCIENCE of March 3 I believe that Dr Gulick is engaged in a research whose results may be of the utmost importance to the health of a large fraction of the human race—namely, the children in the schools—and it is to be desired that he be given every encouragement to continue in it

First, to answer some of his questions in regard to the physics of atmospheric air. No one knows "the reason why" raising the temperature of air increases its capacity for holding moisture It is merely one of the great facts of nature, like gravitation, and like the fact that water freezes at 32° F At 32° F. a cubic foot of air has the capacity of holding in a gaseous condition 0 0003 pound of water, at 62°, 0 00087 pound, at 72°, 0.00121 pound, at 102°, 0 003 pound, and so on

"Is there any difference between steam and humidity?" Steam is water in a gaseous state There is no difference between steam and the gaseous or uncondensed vapor of water in the atmosphere. When steam escapes from a pipe into an atmosphere colder than itself it condenses into fog, which is visible, but if the atmosphere is not saturated with moisture it will rapidly dry the fog, turning it again into invisible vapor Humidity is the condition of the atmosphere as regards moisture. Relative humidity is the ratio or percentage that the moisture contained in the atmosphere bears to the maximum quantity it can contain at the same temperature Thus if a cubic foot of air at 62° contains 0 00087 pound of water vapor, the air is "saturated" and the relative humidity is 100 per cent, but if the same quantity of moisture is contained in a cubic foot of air at 72° the relative humidity is only 0 00087 — 0 00121 or 72 per cent

"The manuals of the heating and ventilating engineers tell us that with a good system of ventilation the opening of windows causes only danger, yet as a matter of fact, children in rooms so treated do not exhibit the distressing conditions," etc

The "danger" from opening windows is not to the children in the room in which the windows are opened, but to the children in the adjoining rooms in which the windows are not opened In the fan-blower or "plenum" system of ventilation the entrance and exit flues and dampers are so designed and adjusted as to cause each room to receive its due proportion of the total air supply If a window is opened in one room (unless the wind is blowing towards the window) the resistance to the passage of air from the room will be less than if only the exit flue were open, consequently there will be a lower static pressure in this room than in the other rooms, and it will receive from the entrance flue more than its proper share, thus robbing one or more of the other rooms of their share The flow of air in a complex system of piping is like the flow of water. If in an apartment house with ordinary plumbing a tenant on a lower floor draws hot water into a bath tub, he will rob the bath room on the floor above of its hot water supply for the time being. So in a school-house fitted with air pipes, if the flow of air from the fan into one room is increased by opening a window, there will be a smaller supply for the other rooms. The "danger" therefore is that of unbalancing the ventilating system. This danger would be avoided if there were in use an automatic ar-

rangement for closing the damper of the admission flue every time a window was opened

The science of heating and ventilation may be divided into two branches (1) hygiene, (2) engineering The first includes the knowledge of the effect upon health and physical and mental vigor of the condition of the air in buildings as regards temperature, relative humidity, content of CO_2 and other noxious gases, etc The second includes the knowledge of how to design, install and operate apparatus which will maintain the conditions that are desired The engineering branch of the science is in fairly good shape. If the temperature, humidity and CO_2 desired in a given school room are specified, the engineers can furnish apparatus which will meet the specifications, and whether or not the specifications are fulfilled can be tested by means of thermometers, hygrometers and analyses of the air in the rooms The hygienic branch, however, is in a very poor shape It is for the doctors to settle, and not for the engineers.

In Dr Gulick's address he threw doubts "upon the very foundations upon which the science of heating and ventilation is built," that is, the hygienic foundations He doubts, I understand, if it is necessary to supply sufficient air to keep the CO_2 down to 8 parts in 10,000, the recognized standard All that the engineers know is that there is a tradition, handed down in the text-books from time immemorial, that the CO_2 should not exceed this limit, and on the generally accepted statements that a man will exhale on the average 0 6 cubic foot of CO_2 per hour, and that the outside air contains about 4 parts in 10,000, the requirement will be met by furnishing 1,500 cubic feet of air per hour to each inmate To be on the safe side, the school authorities in Massachusetts many years ago, placed in their code the specification that 1,800 cubic feet per hour should be supplied for each pupil, and this requirement has been placed in the statute laws of several states.

As to the desired temperature and humidity, and as to the desirability of having artificial ventilation at all, the doctors disagree. Dr. Gulick's letter states that Doctors Thompson and Brennan "think we ought to do away all systems of ventilation, and use simply natural ventilation—open windows," while Dr Leonard Hill has found an "admirable result" from a plenum system, giving a moving air at 57–60° F and about 70 per cent relative humidity with all windows and doors kept closed Both of these ideas are opposed to the modern American system, which is a plenum system maintaining a temperature of 70° F, letting the humidity be what it may, with no attempt to control it A relative humidity of 70 per cent at 60° F is about equivalent in actual quantity of moisture to 50 per cent at 70° F, and this is probably much greater than the humidity in New York schools in clear cold weather

The temperature that is desirable in school rooms is probably largely a matter of habit and local custom Our people are accustomed to a room temperature of 68–72°, and think they like it Englishmen in their own country profess to like 58-62° Which is actually the best temperature, or whether the higher temperature is better here and the lower in England probably no one knows. As to the effect of humidity at temperatures between 58° and 72° F does any one really know? We do know that high humidity at 80° is much more uncomfortable than low humidity at 90°, and we know also that regions of low humidity are famous as health resorts

There is a vast amount of ignorance as to the hygiene of ventilation. Dr Gulick seems to have an arsenal of facts (?) and a body of "as yet undigested information" on the subject, and it is to be hoped that he will correlate and digest them, and present them in digested form before some learned society and have them discussed and printed for the public benefit I venture the opinion, however, that all the investigations by the authorities he names, after being correlated and digested, are insufficient in extent and not sufficiently scientific in quality to form the basis of a final judgment on the disputed questions in the hygiene of ventilation.

What is needed is a new research, aided by all the facilities of modern science and instru-

ments, under the auspices of the Carnegie Institution or the Russell Sage Foundation, to discover by direct experiment on a large scale, the effect upon the health and comfort of school children, of the three different systems of ventilation: (A) Open windows, as recommended by Doctors Thompson and Brennan, (B) the plenum system recommended by Dr. Hill, with low temperature and high humidity, (C) the American plenum system with 70° temperature and low humidity.

For the carrying out of a portion of the research, I suggest that experiments be made in several rooms of a large grammar school, all with the same window exposure and light, one room being treated by direct radiation and all ventilation obtained by open windows, and others by the plenum system, with the volume, temperature and humidity regulated at will. Let the rooms be thoroughly aired, say from 8 to 8.30 A.M., then when the children enter at 9 A.M. have their condition noted by trained specialists, with all the known pathologic and psychopathic tests, including the use of instruments for recording the pulse and the respiration, "reaction time," etc., and let these tests be repeated at noon. Tests should also be made to determine relative mental fatigue, lack of attention, etc. Statistics should be collected to determine what relation, if any, exists between the ventilating system or quality and quantity of ventilation in the schools and the prevalence of adenoids, sore-throat, headache, colds, etc. It may be found that these troubles have relation to the environment of the child during the nineteen hours that he is out of school rather than the five hours that he is in school.

Experiments should be made to find whether the percentage of CO_2 in the school room has the relation to the child's health or mental vigor that it has been commonly supposed to have, and whether an air supply of 600 or 1,200 cubic feet per hour per pupil, instead of 1,800, produces any bad effects. Bacterial examination of the air should be made at the same time.

Such a research as is suggested will take a long time and will cost much money, but is there any investigation now under way that is more worth the money, or that promises more for the welfare of the race?

WILLIAM KENT

TO THE EDITOR OF SCIENCE: I am writing in the endeavor to clear up some of the elementary questions asked by Dr. Luther H. Gulick in his letter "The Air We Breathe," published in SCIENCE of March 3.

When air is completely saturated with water vapor, the humidity in it is vapor, that is, a gas at point of condensation. At other times humidity is a gas, just as much so as CO_2, it is in fact superheated steam in the air. A gas just ready to condense to liquid is called vapor; thus, ordinary steam is a vapor, while superheated steam is a gas, obeying all the well-known gas laws. Humidity is a vapor whenever the air is completely saturated, being then the same as ordinary steam in the air, when, as is usually the case, air is unsaturated, then humidity is superheated steam in the air—a gas. Heat added to vapor superheats it, that is, raises its temperature. Heat taken from vapor condenses some of the vapor to liquid without altering the temperature.

Liquids remain in the liquid state only by virtue of external pressure exerted upon them, and any liquid will quickly turn to gas if all external pressure (which is usually that exerted by the atmosphere) is removed; the tendency for a liquid to gasify depends upon the temperature and kind of liquid, and nothing else.

If a closed vessel containing water and air is let stand at any temperature until conditions have become constant the air will gradually become saturated with water vapor, and the amount of water vapor that will be thus absorbed by a given volume of air will depend only on the temperature of the air, it would, moreover, practically be not only independent of the pressure of the air, but would be the same if another gas or even a vacuum were substituted for the air; also the pressure exerted by the water vapor filling the given space at a given temperature would be the same in all these instances.

In a gas mixture the total pressure exerted by the mixture upon the walls of a containing

vessel is the sum of the pressures exerted by the individual gases composing the mixture, thus, air is a mixture of oxygen, nitrogen, CO_2, superheated water vapor and many other so-called rare gases, and the atmospheric pressure is the sum of all the pressures exerted individually by all these gases

Take again the closed vessel containing water and air; the quantity of water vapor per cubic foot of space above the water, as well as the pressure exerted by this water-vapor, conditions having become constant, will always be the same for the same temperature, but will rapidly increase with rise of temperature The following tabulation shows the maximum capacity of air (or other gas or better simply of space) for water vapor at different temperatures, and also the pressures exerted by the water vapor at these maximum capacities, the values being taken directly from the steam tables of Marks & Davis, Table I

Temperature °Fa	Max Capacity Lbs/Cu Ft Space	Vapor Pressure Lbs/Sq In
32	000304	.0886
40	000410	.1217
50	000587	.1780
60	000828	2562
65	000977	3054
70	001148	3626
75	001346	4288
80	001570	505
85	001832	594
90	002131	696
95	002469	.813

To obtain grains/cu ft multiply lbs/cu ft by 7,000

The extent to which what Dr Gulick calls the "thirst" of air for more water vapor is unsatisfied is the difference between the maximum capacity and the quantity actually present The rapidity with which moisture is evaporated from a moist surface, such as the skin, probably depends, first, on the "thirst" of the air, second, upon the velocity with which the air moves across the moist surface; and third, upon the physical condition of the moist surface, particularly with respect to temperature. Relative humidity is ratio of the quantity of water vapor actually present to the maximum quantity that could be present at a given temperature. Relative humidity will not of itself determine air "thirst," as this "thirst" will be different for the same relative humidity at different temperatures.

Dr Gulick asks, "Does any one know why delicate children and tuberculous persons get well out of doors but fail to do so indoors" I am not a physician but do believe the air "thirst" is certainly, as a rule, far greater indoors than out of doors, and that this "thirst" continually absorbs moisture from the skin, tending to keep it cold and dry and chilling it in local spots

WILLIAM J CROWELL, JR, CH E

TO THE EDITOR OF SCIENCE The capacity of gases for carrying vapors of volatile liquids and the capacity of various volatile liquids to take the vapor form is a subject to which the writer recently has had occasion to devote considerable thought in connection with certain technical processes Possibly some of the confusion which it seems exists in Dr. Gulick's mind may be dispelled by the following statements which I think can be readily verified.

I will attempt to answer the questions propounded by Dr Gulick on page 327 of the March 3, 1910, number of SCIENCE.

1 Water vapor, I believe, is the correct term to be used in a discussion of the hygienic effect of atmospheric humidity since the word steam sometimes conveys the meaning of the cloud of minute water particles resulting from condensation of water vapor in the presence of another gas (air).

2 Water vapor then (the amount of which, compared with the total capable of being carried, in the air at any temperature represents its humidity) does "act strictly in accordance with the ordinary laws governing the movement of gases."

3. Humidity in the air is a term used to express the amount of water vapor in the air usually expressed in terms of the percentage of the total amount capable of being carried at that temperature.

4. Water vapor (as long as it remains in

the vapor form) is a gas and obeys all the laws of gases

5 Air has only the same capacity for carrying any vapor (water vapor) that any other gas has

6 The amount of humidity (i e, the basis for calculating percentage humidity) that air, or any other gas, can carry is not a function of the nature of the gas at all

7 The amount of any vapor that any gas can carry depends solely upon the nature of the substance vaporized and the temperature

8 The actual percentage by volume of vapor which any gas (air) can carry, i. e, the saturation point, is determined by the following formula:

$$\text{Per cent} = \text{Pt}/\text{Atm}$$

Where Pt = vapor tension of the liquid at temperature t, and Atm = pressure of the atmosphere The vapor pressure (the force which a substance exerts to take the vapor form) of water and most common liquids is given in physical tables for all ordinary temperatures

For example, at 20° C (68° F) water has a vapor tension of 17 363 millimeters of Hg Air saturated with water vapor at 20° C, therefore, contains 2 28 per cent If it only contains 1 14 per cent, its humidity is only 50 per cent At 0° C (32° F) the vapor tension of water is 4 569 mm and air saturated at 0° C, therefore, carries only 6 per cent. water vapor, or considerably less than if only 50 per cent. saturated at 20° C

9 Strictly, air is not altered by increase in temperature so that it can carry more water vapor, but the liquid producing the vapor is changed so that it has a greater vapor tension and a proportionately greater percentage of vapor will enter the air

10. The rate of evaporation then from any given moist surface depends upon the actual amount of water the air is capable of taking up (not on the *percentage* of unsaturation) and upon the relative rapidity of movement of the air.

For example, from a square centimeter of skin surface with saturated air no evaporation can take place at any temperature At 20° C, however, and 50 per cent humidity, let us say that 1 14 milligrams are vaporized per minute, then at 0° C and 50 per cent humidity only 3 milligram would be vaporized in the same time Even absolutely dry air at 0° C evaporates less moisture than at 20° C and 70 per cent saturated This is on the assumption that the skin is equally moist at both temperatures and that there is equal movement or no movement of air in both cases

The amount of moisture that may be in the air, whether greater or less, can have no physiological effect, for that already there can be considered a dry gas There need only be considered whether or not conditions are such that much or little or none can be evaporated

11 Perhaps the normal human organism requires the removal of the heat produced by mental or physical activity at a certain fairly definite rate In such case both heat carried away by radiation and by evaporation must be considered, one in a measure supplementing the other Low temperatures increase radiation and decrease heat loss by evaporation and *vice versa*

For example, one extreme condition would be when the air is saturated with water vapor and at or above the body temperature The body then has lost all temperature control At any lower temperature there still remains radiation though the air be saturated.

The other extreme condition would be for extremely low temperatures where, though there is little cooling from evaporation and little moisture produced for evaporation, radiation is excessive and the only remedy is the prevention of radiation by additional clothing

Fortunately at low temperatures when radiation is high, there is little loss from the latent heat of evaporation because air at low temperatures, even if perfectly dry, can carry away little water vapor. In addition to this balance of effect from outside influences, there is the most important physiological influence of perspiration increasing or decreasing the moisture to be evaporated.

Is it not possible, therefore, that the best

physiological condition is that where heat loss by radiation just balances that produced and there is little or no use for perspiration and its evaporation In other words, is not the physiological process of perspiration exhausting and only necessary because the atmosphere is too hot to permit of removal of heat by radiation without the aid of positive physiological effort?

In Atwater's and Benedict's experiments the data given should show the amount of water eliminated to the air from the breath and through the skin This represents a definite number of calories absorbed and should show under the conditions the relation of the amount of heat removed by evaporation to that removed by radiation

These suggestions are made, as you can see, by a novice in hygiene but they may possibly throw a little side light on the problem

LOUIS CLEVELAND JONES

UNIVERSITY FELLOWSHIPS

TO THE EDITOR OF SCIENCE In SCIENCE of February 10, just at hand out here, there appears a letter by Dr. S N Patten upon which I would like the privilege of commenting

The letter divides itself into two main contentions

First, by means of a table of present occupations, an attempt is made to show the prosperity of a group of "fellows," thereby demonstrating the value of fellowships To prove the point the investigation would have to be conducted along lines similar to those recently followed in another connection by Professors Furman, of Stevens Institute, and Cooley, of Michigan[1] As it is, the surface indications presented by this table lead—through the legitimate inferences which may be drawn—to a conclusion diametrically opposite to the one there stated.

Of the 183 fellows listed as living and of known occupation, 27 belong to a group comprised of literary workers, social workers, ministers and students To assume any of these wallowing in a wealth of financial returns offers difficulty to the imagination.

[1] *Proc Soc. for the Prom of Eng Ed.*

The second group, 138, consists of 31 teachers in normal and secondary schools and 107 instructors and professors Lacking specific knowledge as to these individual cases it is fair to reason that these men are no better off than the average of similar ages in their profession From a knowledge of the prevailing conditions it would be proper to assume that $1,200 would not be far from the average salary of this group Under present-day conditions this looks more like "starvation" to me than, perhaps, it does to one who pictures to himself living on an equal salary at the same age, under the conditions of thirty years ago.

This disposes of all save 18 experts and business men Lacking specific evidence, it is fair to presume that this 10 per cent is financially more prosperous than the other 90 per cent

I hope that Professor Patten will complete his table, adding, for instance, the individual ages and salaries This would give a chance for comparison with an equivalent group of non-fellows, at all events, it would transfer the matter from the realm of speculation to that of hard fact.

But it is the second of Dr Patten's contentions which interests me more. He lays down the dictum that it is "rapidity of promotion and not lack of it that ruins promising investigators" To sustain this he gives a couple of inconclusive instances. In neither case are the returns, upon which to base final judgment, yet in

To test his statement I jotted down a list of American scholars whose names occurred to me offhand, for one reason or another Then I looked up their date of birth and of call to full professorship The table follows, and the only name on my list omitted below is that of William James, whose call was deferred to his forty-third year because he started out in the field of anatomy and physiology and when he shifted to philosophy had his apprenticeship term as assistant professor to serve all over again.

Does this list bear out the conclusion that an early call or rapidity of promotion is the

ruin of promising scholars? I, for one, should like to see a much longer list like the foregoing compiled by, let us say, the editor of "American Men of Science." It would be interesting to see the result.

Name	Year of Birth	Year of Call	Age at Call
Gray, Asa	1810	1842	32
LeConte, Joseph	1823	1852	29
Gibbs, J. W.	1839	1871	32
Rowland, H. A.	1848	1876	28
Michelson, A. A.	1852	1883	31
Remsen, I.	1846	1872	26
Brooks, W. K.	1848	1876	28
Gildersleeve, B. L.	1831	1856	25
Hale, W. G.	1849	1880	31
Welch, W. H.	1850	1879	29
Osler, W.	1849	1874	25
Wilson, H. V.	1856	1885	29
Thurston, R. H.	1839	1871	32
Walker, F. A.	1840	1873	33
Fisher, I.	1867	1898	31
Sumner, W. G.	1840	1872	32
Giddings, F. H.	1855	1888	33
Clark, J. B.	1847	1877	30
Carver, T. N.	1865	1894	29
Seligman, E. R. A.	1861	1891	30
Ely, R.	1854	1881	27
Commons, J. R.	1862	1892	30
Patten, S. N.	1852	1888	36

If "young men should be left alone until they are fully developed before transplanting them" they form a curious biological exception. It is a novel contention that prolonged subordination best prepares for initiative and resourcefulness—for intellectual independence and leadership.

If "scholars are not born, they are made by their environment," some change in environment during their period of greatest growth might possibly prove to be stimulating and broadening—particularly if the change were such as, by offering easier financial conditions, freed their time from, let us say, assisting overworked wives in household duties.

The picture of President Jordan conducting a publicity bureau and "dragging into the limelight young men that it would have been better to leave alone" is enjoyable—their being in the statement just enough of that element of contrast which is the essence of humor.

It is true that President Jordan, at the opening of Stanford, called a group of professors whose ages ranged from 31 to 42 years, all but two of them, however, holding full professorships elsewhere at the time—but I, for one, am unaware of his having ever dragged any one of these, or his subsequent appointees, into the limelight. As for these subsequent appointees, their ages have been about 40, I should estimate, as an average. Stanford has offered no marked exception to the general trend of increasing age at promotion to full professorship.

In conclusion, I would like to say that it is significant to note the discussion called forth by the comparatively trivial question of fellowships, contrasted with the silence on the really vital subject presented in John Jay Chapman's letter to SCIENCE last summer. I wish you would reprint that communication now that the season of academic vacation is past.

GUIDO H. MARX

STANFORD UNIVERSITY, CAL.,
February 17, 1911

UNIVERSITY FELLOWSHIPS

TO THE EDITOR OF SCIENCE: Reading Dr. Patten's criticism of Dr. Jordan's address I must protest against the whole tone of his argument, which seems to be that the inducements offered by the teaching profession are so promising and the chances of rapid promotion so great that they tend to prevent the production of scholars. I wish to give the view of a young man just facing the career of a teacher.

Dr. Patten's statement that "scholars are not born" is open to serious criticism. That they are "made by their environment" is partly true. I would extend this statement to read: "and also unmade by their environment," and this environment is a teaching position at $1,000 to $1,500 a year. He does not state how many of the 188 University of Pennsylvania fellows teaching in universities and secondary schools are struggling along on $1,500 or less trying to pay off debts. He does not state how many of them are unmarried because they can not afford it. I heard a

professor say that a young teacher should not get married, because the profession does not offer a living for two Is this the price a man must pay for learning? Is it worth while? Does it lead to scholarship?

The assistant professor with a family can not, on $1,500 a year, get the necessary literature and books, he can not attend meetings at a distance, or travel and gather knowledge and inspiration from others of his kind Does this lead to scholarship? Is it an inspiration for a university fellow to teach at $1,000 a year in a secondary school? Does this indicate that the market is not overstocked?

I raise a question as to whether "it is the professor that needs endowment" if we are to produce scholars. One reason there are not more scholars in America is because the entering inducements are not sufficient Men prepare for the teaching profession and then turn aside for more remunerative work In the zoological laboratory at Columbia University last year there were five students about ready to come up for the Ph.D degree Of these, three signified their intention of abandoning their plans of following the teaching profession. It is the young men who abandon the call of scholarship They are the ones who need encouragement. It is the getting of more men into the profession that will produce scholars as well as helping those already in it. From the many will come the few real scholars that the nation can produce and these will be the result of heredity as well as of training.

It has been claimed that the greatest intellects in America are among the business men. This may be partly true. If the inducements of the teaching profession had been greater some of these men would, doubtless, be leading scholars to-day.

Dr. Patten's hopes of a promising man are that he will settle down on $1,500 a year, forgetting that he has a family to provide for, that he needs literature, travel and association with others. I can not forget seeing a university instructor spending his vacation wheeling a wheelbarrow. This is not going to produce scholars. It produces assistant professors without enthusiasm or inspiration. The teaching profession is bad enough Why make it worse?

The idea that "no one should have the title of professor until it was fully earned" is good But he should be supported while he is attempting to earn it. If this were done more generously than at present more men would make the attempt. Poverty does not offer a smooth road to learning

C V BURKE

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SCIENTIFIC BOOKS

Human Embryology—Keibel and Mall Written by C R BARDEEN, Wisconsin, H. M EVANS, Baltimore, W. FELIX, Zurich; C. GROSSER, Prague, F KEIBEL, Freiburg, i. Br, F T LEWIS, Boston; W H LEWIS, Baltimore, J. P MCMURRICH, Toronto, F. P MALL, Baltimore, C S MINOT, Boston, F PINKUS, Berlin, F. R. SABIN, Baltimore, G L STREETER, Michigan; J TANDLER, Vienna, E ZUCKERKANDL, Vienna Edited by FRANZ KEIBEL and FRANKLIN P MALL. In two volumes Volume I 550 pp, with 423 illustrations Philadelphia and London, J. B. Lippincott Company 1910.

The publication of this work is worthy of very special notice, for it may well be said to mark an epoch of accomplishment in the study of human embryology, while on the other hand it furnishes exceptionally numerous suggestions of many problems yet to be solved, with the most promising lines of attack.

In the introduction, Professor Keibel brings out vividly, after an excellent historical review, the conditions which led up to the inauguration of the modern study of human embryology by Wm. His. It is fortunate that the great volume of these studies which have been accumulated under this inspiration should now be so fully reviewed and made available by the cooperation of these students of his. The plan of His for an extended exposition of human embryology is thus finally accomplished under the leadership of Keibel and Mall on two sides of the Atlantic

Examination of the first volume gives quite a different conception of the field of human embryology from that obtained from other older text-books on the subject; for instance, Minot's very successful and constructive text-book of twenty years ago. It was evident then that, though much valuable work had already been done in various lines, it was still of a scattered character and unorganized. The effect, as a whole, was inconclusive. There were very few topics which had been studied with thoroughness or on sufficient human material.

In the new book we find that a considerable mass of fresh facts and accurate information have been accumulated, from intensive and systematic studies of a far more complete series of embryos, by more effective methods. Though much remains to be done in every department of investigation, it is now clear that the study of human embryos has become organized. Extensive collections are accessible. There is a systematic effort to obtain more complete records in every chapter of the history. The comparative and experimental method is not less used, but has become more an aid to interpretation, while the results secured from the study of human material itself now overshadow all else.

Another striking feature of the new book is the fact that it is the product of a cooperation between so many active American anatomists with well-known Germans, and that it is published, at the same time, in two languages. This is not only a recognition of the extent of His's influence, and of the general wide growth of a cooperative spirit in scientific anatomical research, which has become very marked in this science; it is also a substantial appreciation from abroad of the effective work which has been done in embryology among our anatomists in recent years. Almost every chapter of the book enforces this fact, and the use of illustrations and references to contributions from Americans published in the *American Journal of Anatomy* is frequent. Nine of the fifteen editors are Americans and, of these, five are pupils of Dr. Mall, whose initiative and stimulating example have encouraged much of the activity in embryological investigations of this character in this country.

Keibel writes the more general chapters in the first part (90 pages), including the historical introduction, the account of the germ-cells, fertilization, segmentation, young human ova, germ-layers and gastrulation, and a general summary of the development of the embryo. The rather restricted space given to these topics, which are treated so extensively in Hertwig's "Handbook of Comparative Embryology," is an illustration of the limitation of the scope of the new work to the results of the study of human material. Much of the greatest interest connected with these topics is here necessarily omitted, but there is a decided advantage in exhibiting the actual status of our knowledge. All through these chapters Keibel's fine critical judgment is evident. One receives the true impression that the writer has thorough personal familiarity with the facts. Nowhere is a nice judicial decision in such demand as in discussions about young human ova, hence we are especially glad to find this chapter by Keibel, whose treatment is masterful and illuminating. The tables are new and the details of comparison of young stages are satisfactory. The reader has an opportunity to secure a necessary amount of detail often lacking, confused or pointless in other accounts. The obstetrician will find much of interest here. Keibel's discussion of germ-layers is especially well put. The summary and résumé of the general history of the embryo based on the His and Keibel-Elze Normentafeln of human embryos is excellent, the little critical accounts of each important embryo being well worth while.

Grosser's long chapter (90 pages) on menstruation, implantation, placentation, membranes, etc., is based on extensive personal investigations. This account is almost a monographic treatment of these subjects. The obstetrician will find a mine of discoveries in this chapter and the two following ones. The trophoblast, chorion, villi, decidua,

placenta, menstruation, ovulation, age of embryos and other related topics are given proper attention, and put in the most modern light An excellent basis is laid by precise description for further work in the histological or pathological study of membranes and uterine conditions, and a better idea is now possible of the physiological environment of early embryos, especially from the new young human embryos described in detail

In his chapters (60 pages), Mall advocates a new and improved method of measuring embryos, which may also be applied to the adult His analysis of our knowledge of the age of embryos, growth rate, etc, is original, and results in new curves and tables of development He thus furnishes us a standard, the result of a wide experience with all known data His chapter on pathological embryos is novel and an advance in view point It represents the essentials of his very extensive publications on this subject The types of abnormalities, percentage of abortions, and the association of the pathology of the membranes with these are discussed This leads up to an analysis of the bearing which experimental studies, mechanical and chemical, leading to the production of definite monstrosities in other forms, probably have on the origin of abnormalities in human embryos Medical students and pathologists will turn to these chapters freely, and general embryologists will find here interesting significance in their work.

The second half of the first volume is devoted to the first chapters of the development of special systems of organs, which will be continued in the second volume. An examination makes it plain that these chapters were not written for beginners, though the treatment is direct and clear enough for any one Even this first volume is sufficient to show that there is now ample material for satisfactory courses in mammalian embryology of advanced character, specially adapted to medical students.

It is evident that the time has come for our anatomical departments to insist that students beginning anatomy should have already obtained, during their two years of pre-medical college work now generally required, sufficiently thorough courses in elementary vertebrate embryology, to permit of properly introducing them to the later stages, in man and mammals, which have so much significance for their work in human anatomy.

The fifty pages by Pinkus, devoted to the integument, proves to be a consideration of many interesting aspects of the growth of the skin structures often not insisted upon For in the treatment of pigmentation, glycogen, fat, glands, hair and hair tracts, and of the friction ridges and metamerism, we have emphasized the value of more general studies like those of Galton, Wilder, Sherrington, Bolk and Harrison The special circulation, lymph supply, and nerve supply of the skin are largely left for the writers who shall describe these systems

Bardeen's section (150 pages) on the skeleton and connective tissues may be characterized as encyclopædic in the inclusion of so great a mass of data It is a storehouse of information, the variety of which has made the task of collecting and arranging very difficult The author has exhibited much energy and skill in handling the material, to which he has contributed considerable of value Mall's views are accepted as the most reasonable for the origin of the reticulum and fibrillæ of this tissue Some of the most welcome sections on the skeleton are those on joints, and on variation and abnormalities in development The origin and changes of form of vertebræ are illustrated by Bardeen's models, a set of which should be found in every anatomical laboratory The treatment of the development of special regions of the skeleton, of ossification centers, of the length and curvature of the spine, is accompanied by valuable figures and diagrams The skeleton of the limbs is taken up with similar fulness and contains further contributions from the author, many figures new to text-books, and useful tables The skull is studied in forty pages with a proper reference to comparative embryology where also much has been done, and such important complicated regions as the

orbit, temporal and nasal regions, and the visceral arch derivatives are considered separately. The author publishes, for the first time, two new views of the skull of a twenty-millimeter embryo which combine numerous interesting relations. It is a pity that the details of these figures are not better shown in the half-tones. Anatomical illustrations are being steadily improved, and this is shown in many figures in this edition; but far more care is yet required in both the printing and selection of suitable paper, before the standard of German editions can be approached. The chapter closes with an extended account of the ossification of the individual bones of the skull.

The development of the muscular system is described by W. H. Lewis in about seventy pages. We find this an excellent account, well planned and comprehensive, while at the same time concise and logical. The influence of a participation on the part of the writer in embryological studies of an experimental nature is quite evident and gives a modern point of view.

The chapter is well illustrated, many of the figures being original, and some published here first. It is possible to obtain from them and the text a good idea of the origin and development of the various muscle groups. The author's contributions to the development of the muscles of trunk and limbs, and more recently of the head, tongue and larynx, are outlined here with figures from his new models. Futamura's striking series of pictures representing the stages of spreading of the facial musculature forms an interesting feature.

Only twenty-four pages are allotted to the last section, including the septum transversum diaphragm, and the cœlom, but the subject is brought up to-date by Mall with the aid of new investigations in addition to his previous extensive studies and the conditions found in a number of recently described young human ova. Broman's work is also incorporated to advantage.

One praiseworthy feature is the extensive bibliography at the end of each chapter.

Though the printing of the illustrations and the general make-up of the German edition is decidedly superior to the English, the American publishers have, on the whole, succeeded in making the volume a creditable one. The second volume, now in press, will be anticipated with much interest.

H. McE. KNOWER

CINCINNATI, OHIO,
February 18, 1911

SPECIAL ARTICLES

THE ORIGIN OF NINE WING MUTATIONS IN DROSOPHILA[1]

IN the following preliminary report I wish to put on record some of the principal wing mutations that have appeared in cultures of the fruit fly, *Drosophila ampelophila*. In another communication I shall describe five mutations in eye color that have been found in the same cultures, and their modes of inheritance. The theoretical questions involved must be deferred until the complete data can be published. These mutations have appeared in such rapid succession that my time has been almost entirely consumed in producing pure strains of the new forms, which can be utilized later for a thorough study of the inheritance of the new types. I wish here merely to call attention to the fact that while most of the new types breed true from the start, others do not; and also to the fact that while certain of the mutations are sex-limited other mutations involving the same organs do not show this form of inheritance. It may appear that we have here an opportunity to learn something further of these different modes of inheritance appearing in the same animal. One fact especially will impress itself on any one who follows the history of these new types, viz., the "segregation" of the characters, and in most cases the absence of intergrades.

Beaded Wings.—In May, 1910, a number of flies, pupæ, larvæ and eggs of *Drosophila* were subjected to radium rays. One fly was pro-

[1] The main facts in this paper were given before the American Society of Zoologists, December 29, 1910.

duced, the marginal vein of whose wings was beaded Bred to his sisters, the beaded condition appeared in one fly in sixty of the next generation The beaded flies were inbred and produced in the third generation, one beaded winged fly to thirty-five normal The beaded flies produced in the next generation one beaded to twelve normal wings The same process continued through many generations has finally produced stock that gives in certain cultures nearly 100 per cent beaded wings

Not only has selection slowly increased the percentage of abnormal wings, but much more extreme forms of the same variation have appeared, and an attempt is now being made to fix some of these extreme variations

When a beaded male of the stock in its present condition was bred back to the wild females the beaded condition appeared in one fly in twelve of the first generation In the second generation from non-beaded flies the proportion was one to twenty

In the further course of the experiment eight other modifications have appeared that are undoubtedly mutations, one confined largely to females, some of the others showing strictly alternate inheritance, combined with "sex-limited transmission" These modifications may be described under the following headings

Truncated Wings—The normal wings of *Drosophila* are longer than the abdomen, extending for about one third their length beyond the end of the body The wings have a rather pointed end In the seventh generation of the beaded wing stock a fly appeared with the end of the wings cut off nearly squarely, and indented at the end or somewhat scalloped Bred to sister flies there were produced in the next generation twenty-one flies with truncated wings to 230 with normal wings. In the next generation some of these truncated winged flies produced nearly 50 per cent of flies with truncated wings. It has proved difficult to pass beyond this point, although certain of the later cultures have produced over 90 per cent. of truncated winged flies This high average has not, however, been maintained in the next generation There are indications, nevertheless, that the inheritance may be raised even to this high standard Two main points of interest have appeared in the breeding of this modification First, the condition is confined almost exclusively to the female line A comparison of many cultures shows that the offspring of truncated parents consist of almost equal numbers of males and females with normal wings, while the truncated winged forms are, as stated, confined almost exclusively to the females The deficiency of males in the entire culture is due, therefore, to the absence of males with truncated wings Yet such males appear in small numbers, and especially in cultures in which truncated males are the fathers of the next generation

Secondly, by selecting the shortest-winged individuals in each generation the wings have been reduced in some cases until they are not longer than the abdomen, and in a few cases they were even much shorter than the abdomen, and are not superficially different in this respect from the type to be next described, although in their inheritance they follow an entirely different procedure. The character can not be said to be sex-limited to the female in the conventional sense When a female with truncated wings was bred to a normal wild male all of the offspring in the first generation had long wings These inbred produced in the second generation 1,826 normal flies to 36 truncated individuals, males and females When a truncated male was bred to a normal wild female all the flies in the first generation were normal, and in the second generation, when these were inbred, there were produced 1,408 normals to 14 truncated males and females These facts indicate that this condition is not connected with sex-limited inheritance, although other wing modifications, as will be shown, are intimately connected with sex transmission It should be added that normal winged flies of this modified stock throw a high, though variable, percentage of flies with truncated wings

Rudimentary Wings—In the second generation of the beaded winged flies a male ap-

peared with wings shorter than the abdomen. The square, short wings were broad and often blistered; in individuals obtained later their ends were crenated at times as though incompletely unfolded, but at other times the ends were quite even. This fly, bred to his sisters, reproduced the same condition in a few of his male offspring, and in closely related stock a few males of this kind appeared in successive generations. By repeated intercrossing a large number of these males have been produced and some females. It is important to note that although I have paired numbers of these males and females together I have obtained offspring in only a very few cases and these were all normal flies. Inbred these normal flies have produced 964 normal males and females, 6 short winged males and 2 females. Whether the original short winged females were virgins may appear doubtful from these facts. On the other hand the males and females with rudimentary wings are fertile, both with wild flies and with the mutations to be next described. The frequent failure to obtain fertile eggs from pairs of flies with rudimentary wings may seem therefore to indicate that this combination is generally sterile, but whether because the eggs are not fertilized or being fertilized do not develop is uncertain. This point is being further investigated. The extraordinary deficiency of individuals of this class in the second filial generation (see below), may be due to the same causes that account for the deficiency when inbred. Similar deficiencies, though not so extreme (see the second generation of white-red eyed and black-yellow crosses), run through nearly all of the results with my new races.

If a male with rudimentary wings is bred to normal females of *the original stock* all of the offspring have long wings. These inbred produce variable percentages of long and rudimentary wings. A partial census of the results gave 5,850 normal wings to 83 males with rudimentary wings. No intermediate types appeared. Later several males with rudimentary wings were bred to a new *wild stock*. The offspring had long wings. These flies inbred produced in the next generation 8,459 normals, males and females, and only 32 males with rudimentary wings. The experiments show that the condition of rudimentary wings is sex-limited. By suitable combinations this sex-limited character has been combined with another sex-limited character, viz., white eyes. The theoretical questions involved in such a combination have been discussed elsewhere.[6]

Miniature Wings.—In the seventh generation of the beaded wing stock a fly appeared with wings like the normal in form, but extending no further than the end of the abdomen. Flies with wings of this kind are much more viable than those with rudimentary wings. Pure cultures of thousands of individuals are now on hand. The character also shows itself to be sex-limited. Many combinations between these flies and those with other modifications have been made. Only a few of these can be now mentioned. Miniature wings have been combined with the white eyes, also a sex-limited character.

If a male with miniature wings is crossed with a wild female all of the offspring have long wings. These inbred have produced 409 flies with normal wings, males and females, and 178 *males* with miniature wings. No females with miniature wings appeared in the second generation. Miniature wings are, therefore, sex-limited in inheritance. The reciprocal cross, viz., females with miniature wings by wild males, gave in the first generation 50 females with normal wings and 51 males with miniature wings. Evidently the male-producing sperm of the wild fly does not carry the character essential for the *formation* of long wings. This same spermatozoon also lacks, as I have tried to show, one of the factors essential for the formation of red eyes, likewise a sex-limited character. The F_1 flies, inbred, produced 785 normal males and females (in approximately equal numbers) and 827 flies with miniature wings, of which 430 were females and 397 were males. This result gives the expectation for this combination

[6] *Proc. Soc. Experimental Biology and Medicine*, Vol. 8, October, 1910, and *American Naturalist*, February, 1911.

It will be noted that the flies with miniature wings are even more numerous in this generation than the normal flies Their chances for development are therefore at least equal

Balloon Wings—Occasionally flies have appeared, especially in the truncated winged stock, with each wing swollen up into a balloon or bladder filled with fluid When these become dry the walls collapse and form flat plates that are carried at right angles to the body Some of these flies have been isolated and have produced practically pure stock with the character present in all of the individuals, and this condition has been carried through two generations The flies are exceedingly active and look like small X's running about in the bottles They can not of course fly They seem to be very sterile and produce only a few offspring, but nevertheless I have more than a thousand of these flies alive at present

Albino Flies—Several times flies have appeared that failed to develop black pigment in the body The eyes were red, *i e*, unmodified by the lack of body pigment One of the albinos had white eyes, it is true, but it arose in white-eyed stock, so that the colorless eye bore no relation to the absence of pigment in the body The wings of these albinos were almost white with a faint brownish edge The hairs of the body were brown instead of black Although some of these flies lived for nearly a week they left no offspring When the normal fly emerges it lacks pigment except in the eyes

Melanistic Flies—In some of the crosses between wild flies and those with miniature wings there have appeared in the second generation some flies, males and females, with black wings The veins of the wings are broad and conspicuous Pure stock of these flies was easily, and at once produced The dark color is not confined to the wings, but the entire body is black The type is clearly a melanistic variation of *Drosophila* Crossed with wild stock the flies of the first generation are intermediate in color between the black and the normal type The color does not seem to be sex-limited in relation to the normal, so far as the experiments have been carried.

Yellow Wings—A male appeared in the black-winged stock with golden yellow wings In fact the entire fly is conspicuously yellow and makes a striking contrast with his dark companions He was bred to his black sisters and gave only black flies in the first generation These were inbred and have produced 233 black females, 127 black males and 76 golden winged males Evidently the color is sex limited in relation to the melanic type from which it arose The same or a similar mutation, has appeared again in a stock not related to the first except in so far as both came originally from flies with miniature wings As yet only males have appeared These have given in the first generation (when crossed to their normally colored sisters) normal flies

Wingless Flies—Occasionally flies appear without wings, but this character is not inherited as a rule, and is due to some difficulty in unfolding the primordia of the wings But in some of the stock of truncated wings I have obtained a considerable number of flies with tiny scales in place of wings In one culture there appeared 11 flies with scales, instead of wings, amongst 125 winged flies Although this stock is very sterile it seems not improbable that, in time, a wingless fly can be produced

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THE NATIONAL CONFERENCE COMMITTEE ON STANDARDS OF COLLEGES AND SECONDARY SCHOOLS

THE fifth annual meeting of the National Conference Committee on Standards of Colleges and Secondary Schools was held at the rooms of the Carnegie Foundation for the Advancement of Teaching, 576 Fifth Avenue, New York, N Y, on Saturday, January 28, 1911

All the organizations which send delegates to the conferences of this committee were represented, those in attendance being as follows

President George E MacLean, The State University of Iowa, representing the National Association of State Universities

Headmaster Wilson Farrand, Newark Academy, representing the College Entrance Examination Board

Professor Nathaniel F. Davis, Brown University, representing the New England College Entrance Certificate Board.

Dean Herman V. Ames, The University of Pennsylvania, representing the Association of Colleges and Preparatory Schools of the Middle States and Maryland.

Principal Frederick L. Bliss, The University School of Detroit, representing the North Central Association of Colleges and Secondary Schools.

Chancellor James H. Kirkland, Vanderbilt University, representing the Association of Colleges and Preparatory Schools of the Southern States.

President Henry S. Pritchett, representing the Carnegie Foundation for the Advancement of Teaching.

Dr. Kendric C. Babcock, as substitute for Dr. Elmer E. Brown, the United States Commissioner of Education.

Dean Frederick C. Ferry, Williams College, representing the New England Association of Colleges and Preparatory Schools.

In its desire to help in the establishment of a uniform and convenient terminology, the committee had requested a sub-committee to prepare for this meeting a report with regard to the use of the terms "hour," "count," "unit," "period," "exercise," "point," etc., in secondary schools and colleges. Mr. Farrand, chairman of the sub-committee, reported the results of the investigation which had been made and embodied these results in the following resolution, which was unanimously adopted.

Resolved, that this committee recommends, as a matter of convenience and to secure uniformity:

1. That the term *unit* be used only as a measure of work done in secondary schools, and that the term *period* be used to denote a recitation (or equivalent exercise) in a secondary school.

2. That the term *hour* be restricted to use in measuring college work, and that the term *exercise* be used to denote a recitation, lecture or laboratory period in a college.

3. That *unit* be used as defined by this committee, the Carnegie Foundation, and the College Entrance Examination Board, and that *hour* be used preferably in the sense of year hour.

4. That the use of other terms such as *count*, *point*, *credit*, etc., in any of these senses be discontinued.

The sub-committee had been requested also to consider and report on the desirability of agreeing on the precise use of the terms "programs of study," "curriculum" and "course of study." Mr. Farrand reported that this question had been carefully considered by his committee in the light of the published resolutions of the National Association of State Universities and of the Association of American Universities and such further information as could be procured. While conscious of the desirability of uniformity in the use of these terms, the sub-committee felt that it was unwise to take any action until some common usage should have become established in many institutions.

Following a discussion of the question of a combination of the examination and the certification methods of admission to college, Dean Ferry presented the following resolution which was unanimously adopted:

Resolved, that this committee endorses the movement of various colleges in the direction of attaching weight to the school record of each candidate in connection with his entrance examination, and recommends to the colleges that such records be regularly used as an aid in determining the candidate's fitness for admission to college.

The question of the proper use of the term "honorable dismissal" was considered at some length and the secretary was requested to obtain further information on the subject and to report at the next meeting.

Various questions proposed for discussion were laid on the table and the sub-committee, consisting of Headmaster Farrand, chairman, Principal Bliss, President Pritchett and Dean Ferry, was continued with a request that it report again at the next meeting.

The officers of the past year were reelected as follows:

President—President George E. MacLean.

Vice-president—Headmaster Wilson Farrand.

Secretary-treasurer—Dean Frederick C. Ferry.

The full report of the proceedings of the conference will be printed for distribution to the members of the associations which are represented in the committee.

FREDERICK C. FERRY,
Secretary-treasurer

ANTHROPOLOGY AT THE PROVIDENCE MEETING

THE annual meeting of the American Anthropological Association was held in Providence, R. I., December 28–30, 1910, in affiliation with the American Folk-Lore Society. The sessions were held in Manning Hall, Brown University. In the absence of President William H. Holmes, Professor Roland B. Dixon presided. The attendance was good and a number of important papers

were presented On the morning of December 29 there was a joint meeting of the association and the Archæological Institute of America in Union Auditorium, at which Miss Alice C Fletcher presided

ADDRESSES AND PAPERS

In the absence of President Henry M Belden, of the American Folk Lore Society, his address was read by Dr Charles Peabody Some of the most important papers read at the joint meeting are represented in this report by abstracts These are

Recent Progress in the Study of South American Indian Languages Professor ALEXANDER F CHAMBERLAIN

The author pointed out the regions of the South American continent to which, during the last five years, scientific research had been particularly active the Colombia-Venezuela borderland, northwestern Brazil, Ecuador Peru Bolivia, southern Brazil, etc Noteworthy are the investigations of Tavera Acosta, Koch Grünberg, Rivet and Beuchat, Farabee, E Nordenskiöld, von Ihering, et al To Tavera Acosta we owe rather extensive vocabularies of the Guahiban, Piaroan, Puinavian, Salivan and Yaruran stocks, all of which hitherto have been rather scantily represented by linguistic material Koch Grünberg, as a result of his sojourns in northwestern Brazil, has shown the Makuan to be an independent stock and added much to the linguistic material in print and in manuscripts concerning the Arawakan, Cariban, Betoyan, Miranhan and Uitotan stocks Rivet and Beuchat studying the extensive linguistic material obtained by the former of these authors (they are now working jointly), have thrown much light on the ethnologic problems of the Ecuador Peruvian border land, delimiting the areas of the Jivaran (Rivet has shown Brinton's "Jivaro" to be really Jebero and, therefore, Laman, or as he terms this stock, Cahuapana), Zaparan, Laman (Cahuapana), etc Rivet believes that the Jivaran has marked Arawakan affinities, and his later studies claim to attach some of the minor stocks of southern Colombia to the Chibchan Dr Farabee's investigations have resulted in the accumulation of much lexical and grammatical material concerning the Arawakan peoples of Peru, also vocabularies, etc, from tribes of Panoan, Uitotan, Jivaran and other stocks The thorough study of this valuable material will add not a little to our knowledge of the linguistics of the Peruvian area E Nordenskiöld has devoted some attention to the little-known tribes of eastern Bolivia, and we may expect other data of value from him in the near future To von Ihering belongs the credit of having first established beyond a doubt the independent character of the Chavantean stock Here should be mentioned also the researches of Barrett recently initiated into the language of the Cayapa, etc, of the Barbacoan stock Of works of a more or less bibliographical character the most important are Lenz's monograph on the Indian elements in Chilean Spanish, Schuller's contributions to Araucanian bibliography, etc, and Mitre's "Catalogo," with its introduction by Torres

Recent Literature on the South American "Amazons" Professor ALEXANDER F CHAMBERLAIN

The author résuméd and discussed the monographs of Lasch, Friederici and Rothery, all published during the year 1910 Of these the study of Friederici seems the most satisfactory, the book of Rothery, however, the most ambitious, treating the ancient and modern Amazons all over the globe Dr Friederici rejects the view of Ehrenreich and Lasch of a unitary origin of the Amazon legends among the northern Caribs, with extension thence over all northern South America Both in content and origin the Amazon legends differ notably from each other in several cases, and they are of multiple provenance In some there is evidence of modification and contamination through European sources Among the causes of the origins of South American "Amazon" legends he enumerates the following

1 The notably war like character of women in many primitive American communities

2 The peculiar power or influential position of women (due to economic, religious, hereditary or other social reasons) in a few tribes, which made a great impression upon the mass of the surrounding communities

3 Rumors of the barbaric splendors of the empire of the Incas, which had penetrated the wilderness to the east

4 Reports of certain unusual sexual relations of Indian women, etc

5 Tales of "Amazons" due to native reports misunderstood by the Spaniards, or from such tales intentionally spread by the latter

Amazon legends are reported from the West Indies (Ramon Pane records a characteristic one), from Yucatan and from Mexico The Mexican legends, Dr Friederici thinks, are "the least founded of all, ethnologically or mythologically"

(p. 23). Ill founded likewise are the legends from California and the northwest Pacific coast. Incidentally, Friederici points out that the account attributed generally to Orellana belongs really to Carvajal, and that the river of the "Amazons" received its name from the valor of the Indian women met with by the Spanish explorers.

The Uran: A New South American Linguistic Stock: Professor ALEXANDER F. CHAMBERLAIN.

In 1891 Brinton recognized[1] in the region of Lake Titicaca a Puquina linguistic stock, observing at the same time that "the Puquinas are also known under the names of Urus or Uros, Hunos and Ochozomas." In this he was followed by R. de la Grasserie, in his "Langue Puquina" (1896), and others since then. In 1895–96, Dr. Max Uhle collected from the Urus of Iruitu, etc.,[2] a vocabulary of some 600 words, many sentences, etc., all of which material seems to be as yet unpublished. In 1897 J. T. Polo visited the Urus of Nazacara and obtained a vocabulary of some 150 words, 33 phrases, etc. This material did not appear in print till 1901[3] and constitutes the published linguistic data concerning the Uran stock. The author presented in English alphabetic arrangement a considerable portion of Polo's vocabulary, with grammatical notes, etc. Polo's work seems to have been practically unknown to ethnologists, Roman[4] being about the only one to recognize its importance and to see that the Uran and Puquinan must be unrelated. Careful examination by the author of this paper of the Uran linguistic material and comparison with Atacameñan, Puquinan, etc., prove beyond a doubt that the language of the Urus of Bolivia constitutes an independent family of speech. The few descendants of the ancient Urus, and the fewer still who keep their mother tongue (many having adopted Aymará) are to be found scattered along the Rio Desaguadero between Lake Titicaca and Lake Aullagas or Poopo, particularly at Iruitu, Sojapata, Ancoaqui, Ahuallamaya, Nazacara, etc. In the past they evidently occupied a much wider area between these two lakes.

It is worth noting that the confusion of the Urus with the Puquinas began with Hervas, Garcilasso de la Vega, *e. g.*, among the older authorities distinctly separating the two languages. This separation of the Uran and Puquinan stocks clears up somewhat the linguistic difficulties of this region of South America, but leaves the Puquinas, their origin and the extent of their language area, perhaps as much of a problem as ever.

[1] "American Race," p. 221.

[2] *Globus*, Vol. 69, 1896, p. 19.

[3] *Bol. de la Soc. Geogr. de Lima*, Vol. X.

[4] "Antiq. de la Rég. Andine," Vol. I., 1908.

The Age-societies of the Plains Indians: Dr. R. H. LOWIE.

Age societies have been ascribed by ethnologists to a large number of Plains tribes. A sharp definition of the age factor results in limiting the number to the Blackfoot, Village tribes, Arapaho and Gros Ventre (Atsina). The question arises whether in these cases the age factor is a basic or derivative feature. Investigation proves that the age element is a subordinate feature, the collective purchase of ceremonial regalia, songs and dances being apparently the dominant motive.

Some Aspects of New Jersey Archeology: Dr. CHARLES PEABODY.

Slides were shown illustrating the three celebrated strata at Trenton, N. J., on the glacial terrace above the Delaware River, viz., the black soil, the yellow loam, probably of immediate post-glacial deposition and the true "Trenton" gravels underlying the yellow soil.

Attention was called to certain discoveries made during the season's work of 1910 by Mr. Ernest Volk, who has spent large portions of the last twenty-two years in exploration and observation of the region.

1. *The Bison Bone*.—On June 22, 1910, in the sand pit of Mr. Ahrendt on the terrace was found an artificial pit, the cross section was: at the top six inches of black soil, under this one foot of yellow loam, and under this a red clay band one inch thick. In the pit were found the femur of a bison and accompanying it fine particles of charcoal. In the red band on one side of the pit lay a chipped water-worn pebble of argillite, and in the same red band to the left, a water-worn pebble of argillite, not chipped.

2. *The Artificial Pit*.—On August 23, 1910, in the sand pit of Mr. Ahrendt, on the terrace was found another artificial pit, the cross section: at the top, six inches of black soil, under this yellow loam (with thin red bands) three feet six inches thick, and under this, overlying the pit, three or four inches of brown sand and charcoal. Nothing but charcoal of human provenance was found in the pit.

3. *The Natural Pit*.—In the same sand pit, seven feet down under a somewhat similar series

of natural strata, was a pit made by ice, probably, or by some other natural agency The importance of commenting on these three pits together consists in drawing attention to the similarity of geological and climatological conditions under which the pits were formed Light is shed on the question of the contemporaneity of man with the post glacial conditions which permitted the deposition of the yellow drift and the formation of the series of so called "ice pits", the bison is added to the list of animals which lived as contemporaries with man at this epoch A photograph taken by Mr Volk was shown giving the negative in yellow loam of a large boulder which had fallen out, the similarity of forces which were sufficient to transport such boulders during the formation of the yellow drift with those forces undoubtedly of glacial origin that deposited great boulders in the gravels lower down was insisted upon Reference was made to the continuity, accuracy and fidelity of Mr Volk's work

The Historical Value of the Books of Chilan Balam Mr SYLVANUS GRISWOLD MORLEY

The recovery of aboriginal history in America is exceedingly difficult because of the absence of original sources from which it may be constructed To this general condition, however, the Mayas of Yucatan offer a striking exception Centuries before the Spanish conquest this intelligent people had developed an accurate chronology and a system of hieroglyphic writing by means of which they recorded their annals

These aboriginal records were destroyed at the time of the Spanish conquest, but in the century that followed (1550–1650) there grew up a body of native writings called "The Books of Chilan Balam" in which were embodied much of the aboriginal history of this country The case for and against these chronicles as reliable sources for the reconstruction of Maya history may be summed up as follows

A *Unfavorable*

1 Breaks in the sequence of the katuns, the unit of enumeration used in the chronicles for counting time

2 Certain disagreements, usually of time, in the statement of facts

B *Favorable*

1 Very general agreement throughout

2 Early date at which the chronicles were compiled (1550–1650), when the ancient history had not yet been forgotten

3 Authorship by natives, many of whom had grown to manhood before the Spanish conquest, and who had had, therefore, opportunities for learning their ancient history at first hand, before European invasion and acculturation

4 Many corroboratory passages in the early Spanish writers

There are two important conditions, however, which will explain, in part at least, the discrepancies in the chronicles, which have been noted above under A

1 The original manuscripts have never been studied and compared, and the present translation was made from hand copies only, a condition pregnant with possibilities for error

2 The translation itself is not always accurate and indeed in several instances has been shown to be misleading and incorrect

Recent Archeological Investigations in northern Guatemala DR ALFRED M TOZZER

The area occupied by the remains of the Maya civilization may be roughly divided into various provinces distinguished from each other by chronological considerations as well as by those dealing with assemblage, construction, the manner and method of decoration and others

The area treated in detail is that which includes the northeastern part of the Department of Peten, Guatemala Tikal is the first city of importance in this region To the east is Nakum, first made known to the scientific world by Count de Périgny in 1908, and Naranjo, explored by Mr Maler In addition to these ancient sites the Peabody Museum Expedition of 1909–10 reports the new ruins to the north of Naranjo and Nakum of La Honradez, Porvenir, Azucar, Seibal 2d, and Holmul in Guatemala and those of Kotšikitam in British Honduras

These ruins are all characterized by the presence of one large court or plaza around which in most cases the greater number of stelæ and altars are placed The plan in each case shows a system of oriented courts all connected with one another with very few detached buildings

From a study of the dates now available it will be seen that this region occupies the first position in point of time in all the ruins of the Maya area It is not possible to show at the present stage of the study of the archeology of this section that the Tikal territory was the center from which spread the influence responsible for the cultures of Copan and Palenque From the evidently later character of certain of the stelæ at Tikal, it may be reasoned that not only was this region a center, which began very early in the

life of the Maya civilization, but that it continued to hold its important position until well toward the end of the time, when the southern Maya culture resigned its place of preeminence to that part of the Maya people living far to the northward

The results of the investigations of the Peabody Museum Expedition of 1909–10 will appear in the *Memoirs* of the museum

Cretan Anthropometry Professor CHARLES H HAWES

Since Professor Boyd Dawkins and Dr Duckworth concluded that the ancient Cretans belonged to the long headed dark short Mediterranean race, the examination of additional ancient skulls and measurements of living Cretans made by me have gone far to confirm this conclusion, and to show that the *average* modern Cretan is a modification of this type and has a broader head than his ancestor

Nevertheless, the facts here set forth demonstrate that the ancient Cretans or Minoans with their characteristic long head are still represented in the more inaccessible regions, and that the broadening element is due to the presence of brachycephals who are mainly confined to the plains and coasts Further, the facts are interpreted to indicate that the broad heads are descendants of aliens, and in the main to prehistoric immigrants

The data for Minoan skulls is obtained from 118 crania, of which I use here 78 male skulls (c 2000 B C), leaving out those of the Late Minoan period, during which there is both archeological and anthropological evidence of an alien immigration These 78 skulls yield an average cranial index of 74 0, and the long heads are to the broad heads as 5 to 1

The data for modern Cretans is large, amounting to over 60,000 measurements and observations, and for this reason comparisons are at present confined to the cephalic index Adding 199 Cretans measured by Dr Duckworth to those measured in my expeditions of 1905 and 1909, we have a total of 3,183 But from these have been deducted foreigners, women and children and even Mussulman Cretans, leaving 2,290 modern Cretans as the basis for the following comparisons These yield an average cephalic index of 79 0 to be compared with 76 0 (*i e*, 74 0, the cranial index, plus 2 0, allowance for the cephalic) The average modern Cretan is therefore mesaticephalic, midway between his ancestor, the ancient Cretan, and his neighbor, the modern Greek (c 82 3), and the long heads are to the broad heads in the proportion of 5 to 4 The difference is appreciable and impels us to ask, do the descendants of the ancient Cretans, with a cephalic index of 76 0, exist in Crete to day? If so, it is reasonable to suppose that the invading aliens have driven the natives up into the hills, and there we find them Present in the plains, they predominate in the mountains In the mountain plain of Lasithi (2,700 ft) the average cephalic index is 76 5, with a proportion of 9 dolichocephals to 1 brachycephal On the northern slopes of Mount Ida the cephalic index is 76 5 On the northern slopes of the White Mountains, in the west, in one village, 65 men averaged 76 9 compared with 79 9 in the plains immediately below In the Messara Mountains of the center, the average was 76 9 in contrast to 80 9 in the plains Twenty eight skulls of revolutionists of 1821 and 1866 chosen at random from the mausoleum of a mountain monastery, yielded a *cranial* index of 74 2 and a ratio of 4¼ long heads to 1 broad head In the less accessible mountain regions are thus to be found modern Cretans of similar cephalic index and ratio of dolichocephals to brachycephals to those of Minoan Crete

How then has the *average* cephalic index risen in 4,000 years from 76 to 79? I have already suggested that this change is due to the presence of the descendants of prehistoric immigrants Reviewing historic invasions, it is possible to dispense with both Turkish and Venetian somatological influence Mussulmans have been rigidly excluded from these records and the Venetians, I have shown by a careful comparison of the Venetian named Cretans with the rest, possess exactly the same average cephalic index, thus evincing a breeding out in the course of nine generations of the infusion of Venetian blood that Crete received This leaves us with the prehistoric invasions of the Achæans and the Dorians, which tradition, history and archeology attest Anthropometry witnesses to an invasion of broad heads in the third Late Minoan period (1450–1200 B C) It is to the Dorian inroad, a migration of a people, rather than to the freebooting Achæans, that I attribute the chief part in the broadening of the Cretan head This is best illustrated in the southwest corner of Crete in the eparchies of Sphakia and Selinon The Sphakiots are by tradition and dialect Dorians, and seem to have maintained the purity of their blood by resisting all invaders and by the custom of endogamy They and their neighbors have average cephalic

indices of 80.4 and 80.9 and the broad heads are in the majority of 3 to 2 and 3 to 1. If we assume, as many scholars do, that the Dorians ultimately came from Illyria we have an explanation to hand. The Illyric stock is unmistakable and exceptional in Europe to-day, in that it combines a broad head with a tall frame. In this southwest corner of Crete is a broad-headed people with a stature of 1,709 mm. (cf. Dalmatians 1,711 mm.) whereas the central and western Cretans average 40 mm. less.

A further test made with an instrument I had just invented, the comparison of the sagittal curve of the living head brings out a striking likeness between the brachycephalic Sphakiots, the Albanians (the oldest inhabitants of Illyria) and the Tsakonians, a tribe in the east of the Peloponnesus, 8,000 in number, who still speak a Dorian dialect unintelligible to the Greeks. These three peoples, all with claims to Dorian descent, separated by hundreds of miles, yield exactly similar sagittal curves, and their *normal* types very closely approximate, whereas the contrast to that of the Mediterranean race is extraordinary.

The Social Organization of the Winnebago Indians: DR. PAUL RADIN.

The topics discussed by Dr. Radin included (1) the village organization, (2) the phratries, (3) the clans (animal names, animal descent, clans), (5) the clan functions (clan feasts, clan names), (4) the ceremonials associated with the clans, (5) the clan functions (clan feasts, clan wakes), (6) marriage, (7) death and mortuary customs, (8) the hunt, (9) the warpath.

Dr. Radin closed with a general theoretical discussion of the phratries and clans.

The Religious Ideas of the Winnebago Indians: DR. PAUL RADIN.

This subject was also treated topically: (1) the guardian spirits associated with the ceremonial societies and with the clans, (2) their "nature" (nature deities and "spirit" animals) and the specific powers they control, (3) the "inheritance" of guardian spirits *per se*, and in association with the clan and the ceremonial organization, (4) the "degrees" in the attitude toward guardian spirits, (5) the conception of life, death, future life and transmigration, its bearing on the social organization, (6) the ceremonial associated with the attainment of long life, with death, future life, transmigration, and miscellaneous religious beliefs, (7) the guardian spirits as the basis of the ceremonial organizations and the influence of their disappearance on the type of ceremonial organization, (8) the impossibility of separating the social and religious factors in their attitude toward the guardian spirits and the general conceptions, (9) discussion as to the probable historical development of the religious social complex.

Polynesian Gods: Professor ROLAND B. DIXON.

The characteristics of the four great gods of Polynesia were discussed, and the relative importance of these deities in the different island groups pointed out. Kane, Ku and Lono were suggested as forming a connected group, with Kanaloa quite separate and differing in origin. It was suggested that the latter might probably be derived from a Melanesian deity, whereas the triad showed indications of an origin in Indonesia.

Polynesian and Melanesian Mythology: Professor ROLAND B. DIXON.

The myth incidents of the Polynesian and Melanesian areas were considered in their distribution, and in their relation to the mythology of Micronesia and Malaysia. The general results of this comparison seemed to accord with the theories of migration and cultural origins derived from a study of material culture.

A Pre-Pajaritan Culture in the Rio Grande Drainage: DR. EDGAR L. HEWETT.

On the high bench lands bordering the Chama River on the south, the writer recorded in the summer of 1905 a large number of ruins of a different character from any of the well known ancient Pueblo ruins of Pajarito plateau. During the past summer many more of the same character were noted and surveyed in the Ojo Caliente valley. These ruins consist of foundations of cobble stone inclosing rectangular rooms. Some of the ruin groups are of great extent. A typical group consists of a central circular structure of stone, probably in part subterranean, an open plaza surrounding it, then the foundation walls extending out in all directions. The entire settlement is divided into two parts by a narrow irregular street. That these ruins antedate the great community houses of the Pajaritan culture is shown by the facts that the walls are reduced to the grass level and that these ruins in some cases partly underlie the structures of the latter period.

Abstracts were furnished by some authors who were not able to be present and read their papers. These abstracts are also given.

A Note on the Persistence of some Mediterranean Types: MISS GEORGIANA G. KING.

In Italy and Spain one meets the local frescoes and portraits at times in the streets. I am told that Leonardos and Luinis abound in the Milanese, and a friend of mine has seen a mother and three daughters conspicuously Etruscan in Massa Marittima. Myself I have seen the following and can show photographs for the elder part (I have no modern photographs). In Siena, children like Matteo di Giovanni's. In Viterbo, a woman like the 'Roman School.' In the Emelia, women like Mantegna's and the local school. In Arles, women like the Roman Sarcophagi. In Venice, ecclesiastics like Gentile Bellini's, women like Carpaccio's. In Spain, women like the Lady of Elche.

These last are alike in the matter of figure and carriage and expression, as well as feature.

The Double Curve Motive in Eastern Algonkian Art: Dr. Frank G. Speck.

This paper presents a brief preliminary report of investigations in decorative art being carried on among the tribes of the northeastern Algonkian group, including the Abenadi, Penobscots, Passamaquoddies, Malisits, Micmacs, Montagnais and Nasdapis. The predominant design unit is a figure described for convenience as the "double curve," two opposing incurves. Variations of this elementary figure occur so universally throughout the region discussed, that the double curve motive is really characteristic. While it is also seen occasionally in Iroquois and Ojibway art, it is none the less distinctive of the northeastern Algonkians. Formerly the designs were produced in the moose hair and porcupine quill techniques, and by painting; nowadays most of the examples are seen in beadwork, except among the Nasdapi, where painted decorations still occur. In wood carving and etching on birch bark the more southerly tribes still preserve the old type of decoration.

The main body of material discussed in the paper is based upon collections made among the Penobscots, who are being made the subject of an independent monograph by the writer. Some forty typical forms of the double-curve design, showing different degrees of elaboration, are used. The simplest is the bare double curve, the modifications ranging up through highly complex examples with a score or so of compounded ornaments filling up the interior. In the more modified examples the original double curve unit is sometimes hardly distinguishable on account of the numerous embellishments. Aside from simple ornament, not any particular symbolism has so far been found that would apply to the whole region. Investigations in the field of symbolism have only produced satisfactory results among the Penobscots, where the designs seem to have originally been floral representations with a magical medicinal value through the association of the design with the herbal remedies which play so important a part in the life of these Indians. Judging, however, from the lack of such an interpretation among the Malisits, so far as has been discovered, it would seem, at present, as though the matter will have to be investigated along independent lines in each particular tribal area.

Materia Medica of the Algonkian Indians of Virginia: Mr. J. Ogle Warfield.

This paper treats: (1) Of the subject as recorded by the early authorities. This is far from being full and concise and yet is of value even for the little information it contains. (2) The remnants of these tribes now remaining, having been so closely kept in contact with the English settlers and their descendants for the past three hundred years, have lost all ceremonial functions and ideas connected therewith, and have even lost the limiting of such practise to any particular person or coterie of such persons. That which they use is chiefly in the form of decoctions or "teas" made of barks and roots, which are gathered and made by the mother or grandmother of the family, outward applications are also used. Quite a number of such remedies were obtained. They are not simply recollections of the past, but are used and believed in firmly.

In the absence of Professor Hiram Bingham, his paper on "The Ruins of Choquequirau" was read by Mr. George P. Winship. It and the paper (read by title) by Mr. Stansbury Hagar on "The Four Seasons of the Mexican Ritual of Infancy," are to be published in the *American Anthropologist*. Dr. Edward Sapir's two papers, "The Wolf Ceremonial of the Nootkas" and "The Linguistic Relationship of Nootka and Kwakiutl," will also appear in the *American Anthropologist*.

The papers read, of which the secretary was unable to obtain abstracts were:

Professor Wm. H. Goodyear: "Measurements in 1910 in the Spiral Stairway of the Leaning Tower of Pisa."

Dr. Elihu Grant: "Philistine and Hebrew in Palestine."

Professor E. M. Fogel: "The Survivals of Germanic Heathendom in Pennsylvania German Superstitions."

Professor Arthur C L Brown "Fire and Fairies with Reference to Chrétien's Yvain, vv 4385–4576"

Mr Phillips Barry "A Garland of Ballads"

The following papers were read by title

Professor William H Holmes 'The Place of the Esthetic in Human Welfare'

Professor Junius Henderson "Tewa Ethnozoology"

Mr W W Robbins "Tewa Ethnobotany"

Miss Barbara Freire Marreco "Notes on Tewa Medical Practice"

Mr John P Harrington "The Mesquite and its Uses"

Dr Walter Hough "The Dog in Pueblo, Mexican and Peruvian Mortuary Customs"

Miss H Newell Wardle "The Cradle board in Ancient Mexico"

At one o'clock on Wednesday the twenty eighth, the corporation of Brown University gave a luncheon in the Administration Building, President Faunce receiving The afternoon of the same day was devoted to sight seeing, visits were made to the John Hay Memorial Library the John Carter Brown Library, the Ann Mary Brown Memorial and the Rhode Island School of Design, followed by a reception at the Providence Art Club

GEORGE GRANT MACCURDY

YALE UNIVERSITY,
NEW HAVEN, CONN

FIFTH ANNUAL MEETING OF THE ENTOMOLOGICAL SOCIETY OF AMERICA

THE fifth annual meeting of the Entomological Society of America was held at the University of Minnesota, Minneapolis, December 27 and 28, in the school of mines building The president, Dr J B Smith, presided throughout the session In the absence of the secretary treasurer, Professor J G Sanders was elected secretary pro tem

The following papers were read during the session

"Notes on the Tingid *Leptobyrsa explanata* Heid," E L Dickerson

"Notes on *Sanninoidea exitiosa*," J B Smith

"The Structure of Spermatophores in Crickets," J P Jensen

"The Biological Survey of the Insect Life of Kansas," S J Hunter.

"An Experimental Study of the Death feigning Habits of *Belostoma* (*Zaitha*) *flumineum* and *Nepa apiculata* Uhler," H C and H H Severin

"Announcement of Further Results secured in the Study of Tachinidæ and Allies," C H T Townsend

"Some Suggested Rules to govern Entomological Publications," T D A Cockerell

The report of the committee on nomenclature was received and ordered printed

The report of the executive committee showed that nineteen new members had been received during the year and four lost through death

The result of the mail vote ordered by the society at the Boston meeting was that the annual dues of the society should be two dollars this to include a subscription to the *Annals of the Entomological Society of America*

The following officers were elected

President—Professor Herbert Osborn

First Vice president—Professor Lawrence Bruner

Second Vice president—Professor Alex D MacGillivray

Secretary Treasurer—Professor Alex D MacGillivray

Additional Members of the Executive Committee—Professor J H Comstock, Professor J B Smith, Professor C J S Bethune, Dr W M Wheeler, Dr H Skinner, Dr A D Hopkins

The annual public address was given in Handicraft Hall by Professor F L Washburn, "The Typhoid Fly in the Minnesota Iron Range"

ALEX D MACGILLIVRAY,
Secretary Treasurer

SOCIETIES AND ACADEMIES

THE NEW YORK ACADEMY OF SCIENCES
SECTION OF BIOLOGY

A REGULAR meeting of the Section of Biology was held at the American Museum of Natural History, January 16, 1911, Chairman Frederic A Lucas presiding The following papers were read

Cryptomeric Inheritance in Onagra C STUART GAGER

An abstract of this paper appeared in SCIENCE for February 3, 1911, p 191

Field Notes on Japanese Whales ROY C ANDREWS

The speaker gave an account of a recent seven-months' stay at the Japanese whaling stations, telling of the methods employed in capturing and preparing the whales for commercial use, also of new notes on the habits of finback, blue and sei whales

The latter species, called by the Japanese "sar

dine whale," is referable to *Balænoptera arctica* Schlegel, and although it has been taken for a number of years at the Japanese stations almost no material relating to it is extant. The species is so closely allied to *Balænoptera borealis* Lesson of the Atlantic that further investigation will probably prove it synonymous.

Photographs of the rare North Pacific blackfish (*Globicephalus scammoni*) and of several species of dolphins were also shown. It was announced that a new porpoise of a most peculiar body shape had been secured, and would be described in a future number of the *American Museum Bulletin*.

AT the regular meeting of the section held at the American Museum of Natural History, February 13, 1911, Chairman Frederic A. Lucas presiding, the following papers were read:

Climate and Evolution: W. D. MATTHEW.

The thesis of the paper is as follows:

1. Secular climatic change has been an important factor in the evolution of land vertebrates and the principal known cause of their present distribution.

2. The principal lines of migration in later geological epochs have been radial from holarctic centers of dispersal.

3. The geographic changes required to explain the past and present distribution of land vertebrates are not extensive and do not affect the permanence of the ocean basins as defined by the continental shelf.

4. The theory of alternations of moist and uniform with arid and zonal climates associated, respectively, with partial submergence and extreme emergence of the continental areas, as elaborated by Chamberlin, are in exact accord with the apparent course of evolution of land vertebrates, when interpreted with due allowance for the probable gaps in the geologic record.

5. The numerous hypothetic land bridges in temperate, tropical and southern regions, connecting continents now separated by deep oceans, which have been advocated by various authors, are improbable, inconsistent and unnecessary to explain geographic distribution. On the contrary, the known facts point distinctly to the permanency of the deep ocean basins during the later epochs of geologic time, to the alternate connection and separation of the land areas within the line of the continental shelf and to the continued isolation of those land areas which are surrounded by deep ocean.

These theories are substantially an adaptation of the conservative views of Wallace and other zoologists to the geological theories of Chamberlin. They are defended by a consideration (1) of the nature and extent of the defects in the geological record, (2) of the relations of the zoological regions to each other and the changes effected by elevation or submergence of 100 fathoms, (3) of the principles of dispersal of land animals, (4) of the character of the fauna of oceanic islands (including Madagascar, Cuba and New Zealand) and the degree of probability which attaches to accidental transportation as a means of populating them, (5) of the present and known past distribution of the mammalia, group by group, in considerable detail, (6) of the distribution of the different orders of reptilia in a less detailed manner, (7) of the distribution of birds and fishes, with a few instances from invertebrate distribution which have been especially urged in support of hypothetical bridges, (8) of the objections to such bridges and an interpretation of the real significance of such evidence as has been adduced in support of them.

The speaker believed that the supposed cumulative evidence obtained in various groups of animals or plants for various continental bridges is due simply to identical errors in interpretation running through all such instances. On the other hand, to admit such bridges would seem to involve certain distribution results, which, in the groups which he has studied, assuredly do not exist.

The Limbs of Eryops and the Origin of Paired Limbs from Fins: W. K. GREGORY.

In a skeleton of the temnospondylous amphibian, *Eryops megacephalus* Cope, from the Permian of Texas, which is now being mounted in the American Museum, the limbs are of special interest. Many resemblances to the contemporary reptile *Diadectes* are seen in the stout, long coracoscapula, the short, wide headed humerus, with its very wide, prominent and backwardly directed entocondyle, in the short fore arm, in the very heavy, solid pelvis, stout femur and fully ossified carpus and tarsus. In the character of its limbs *Eryops* was on the whole nearer to *Sphenodon* than to the Urodeles, though far more archaic than the former. As shown by the facets, the humerus and femur were held almost at right angles to the body, the opposite feet being held very widely apart.

The generalized character of the limbs of *Eryops* with respect to those of higher Tetrapoda invite renewed inquiry into the origin of paired limbs from fins. The limbs of known branchio-

saurs and microsaurs do not carry us very far back toward any known type of fish fin In these orders the cylindrical shafts of the long bones, with cartilaginous ends, the cartilaginous carpus and tarsus, the weak shoulder girdle and pelvis suggest a secondary adaptation to aquatic habits

From the work of Thacher, Goodrich, Dean, R C Osburn and others, it seems probable that the paired fins of fishes, like the median fins, have evolved from wide based fins with serially arranged basal and radial cartilages After the formation of the primary shoulder girdle and pelvis and of the pro, meso and metapterygia by fusion and growth of the basals, the various types of paired fins seen in plagiostomes, chimæroids, pleuracanths, dipnoans, crossopterygians and actinopterygians seem to have arisen in each case through the protrusion of the basal cartilages, differential growth and shifting of the radials, and in some cases (*e g*, pleuracanths, crossopterygians, dipnoans) also through the extension of the radials around to the post axial side of the metapterygial axis If the Amphibia have descended from forerunners of teleostomous and dipnoan fishes (as seemed likely) then it was entirely probable that their paired fins had been transformed into limbs through the extreme protrusion of the proximal cartilages, differential growth and regrouping of the more distal cartilages, reduction of the dermal rays This structural change may well have been in large part effected before the air breathing proto amphibians had left the water, owing to the assumption of a new function in the paired fins, *i e*, pushing against solid objects such as roots, in the stagnant water, instead of merely steering A study of the pectoral girdle and fins of *Sauripterus*, a rhizodont crossopterygian of the Upper Devonian, in comparison with those of *Polypterus* and with the limbs of primitive amphibians, had suggested the following provisional homologies

Crossopterygian		*Tetrapod*
"Infraclavicle"	=	Clavicle
"Clavicle" (of Parker)	=	Scapula
"Supraclavicle"	=	Cleithrum
"Coracoid" (hypocoracoid)	=	Coracoid (or pre coracoid?)
"Scapula" (hypercoracoid)	=	Humerus
Proximal basals	=	Radius and ulna
Distal basals	=	Carpals
Radials	=	Metacarpals and phalanges
Dermal rays (derived from scales)	=	Nails, scales

The reduction and loss of the post temporal may have accompanied the freeing of the shoulder girdle from the skull These views differ radically from those of Owen, Parker and Gegenbaur The paired fins of *Sauripterus* were the only ones known that seemed to foreshadow even in a remote degree the paired limbs of the Tetrapoda In the pelvic fin of *Eusthenopteron*, another crossopterygian of the Upper Devonian, differential evolution of the basals and radials had brought about certain remote resemblances to the tetrapod limb The ilium of tetrapods appeared to be a neomorph

L HUSSAKOF,
Secretary

THE AMERICAN CHEMICAL SOCIETY
NEW YORK SECTION

THE sixth regular meeting of the session of 1910-11 was held at the Chemists' Club on March 10, Professor Chas Baskerville in the chair

The election of officers of the section for the session of 1911-12 resulted as follows

Chairman—A C Langmuir

Vice chairman—A B Lamb

Secretary and Treasurer—C M Joyce

Executive Committee—Chas Baskerville, David Wesson, W J Evans and Rudolph Seldner

The following papers were presented

"The Sulphides of Iron," E T Allen

"The Detection of Salicylic Acid," H C Sherman and A Gross

"A Study of the Factors involved in the Qualitative Determination of Barium," E Frankel and L J Curtman

"The Detection of the Platinum Metals by the Glow Reaction," P Rothberg and L J Curtman

"Some New Rare Earth Compounds," Charles James

"Experimental Furnaces for Glass Melts," P C McIlhiney

"Examination of Commercial Oxygen," Reston Stevenson and Chas Baskerville

Before the reading of the last paper, the chairman asked Dr A H Sabin, the first chairman of the section, to preside Dr Sabin, in taking the chair, gave a short account of the early history of the section

Dr McMurtrie had hoped to be present to make some valedictory remarks on the occasion of the last meeting in the original quarters of the Chemists' Club but was obliged to send a written com

munication instead, which was read by Professor Baskerville.

C. M. JOYCE,
Secretary

THE HELMINTHOLOGICAL SOCIETY OF WASHINGTON

THE third regular meeting of the society was held in the zoological division of the Public Health and Marine Hospital Service on January 6, 1911, Dr. Stiles acting as host and Mr. Crawley as chairman.

Dr. Pfender presented a paper entitled "A Few Brief Remarks on Medico-zoological Nomenclature, with Special Emphasis on the Correct Terminology of the Protozoon of Syphilis." The paper points out that persons engaged in preparing new material are in duty bound to use all means that might aid in a clear and correct presentation of their subject. In the medico-zoological field, failure to appreciate this fact has resulted in burdening the literature with numerous erroneous names, the errors being due to medical men and zoologists alike.

In the case of the organism of syphilis, the original errors were made by zoologists, but since being corrected have been persisted in by medical men and other scientific men. Schaudinn in 1905 reported the discovery of an organism which he believed to be the cause of syphilis. Believing that this belonged in the same genus as *Spirochæta plicatilis* Ehrenberg, 1834, he proposed for it the name *Spirochæte pallida,* adopting the emended spelling of Cohn, 1872, for the generic name. About this time Stiles called attention to the fact that Cohn had emended the spelling without reason or authority, hence the correct name was *Spirochæta*. The same year, 1905, Vuillemin decided that the organism did not belong in the genus *Spirochæta* and proposed the name *Spironema,* a change which was accepted by Schaudinn. Vuillemin, however, had not used due care in selecting his generic name, which was preoccupied by Meek, in 1864, for a genus of molluscs, and also, erroneously, by Klebs, in 1892, for a genus of flagellates. Being apprised of this fact, Schaudinn proposed the generic name *Treponema*. This name did not come to the attention of Stiles and Pfender in time to prevent their proposing the generic name *Microspironema,* this last name becoming a synonym under the law of priority. The correct name of the organism of syphilis is therefore *Treponema pallidum* Schaudinn, 1905, and not the popular *Spirochæta pallida*.

The conclusions to be drawn from this case are: (1) it is mandatory that the proper classification of an organism be determined before naming it; (2) every effort should be made to ascertain whether a contemplated name is preoccupied before publishing it; (3) when errors of nomenclature have been made, it is the duty of medical men and other scientists to avoid their repetition, regardless of the popularity of the names; (4) the difficulty of complying with these conditions and with the rules of nomenclature indicates the need of a reform, and this may perhaps be found in the selection of a tribunal of authorities to which proposed names must be submitted for approval and by which the status of names may be settled.

Mr. Hall presented two short notes on gid. The first one, accompanied by the exhibition of a couple of skulls of sheep dying of gid, called attention to the fact that the skulls of yearling sheep and lambs are very thin, and that in the case of sheep having gid, this thinness is increased in the vicinity of the parasite, commonly resulting in actual perforation of the skull in a number of places. The natural thinness and the thinness and perforation resulting from gid make it easy for dogs to get at the parasite and become infected. Experiment shows that they do this either by crushing and eating practically the entire skull, or by inserting the tongue in the foramen magnum and licking out the brain.

The second note dealt with a case of unusual delay in the development of the adult tapeworm, *Multiceps multiceps,* in the dog after feeding the larval gid bladderworm from the brain of the sheep. In this case the dog was killed 82 days after the feeding, and examined post mortem, the feces up to this time having shown no tapeworm eggs or proglottids. Five specimens of the gid tapeworm were found in the dog, the largest having eggs in the uterus, but with no onchospheres as yet developed. The two smaller specimens were less than half an inch long. The dog had been on a diet limited to salt meats or cooked beef and bread, and had had no opportunity to acquire infection with any tapeworm except *Dipylidium*. The usual period of development of the gid tapeworm is given by various authorities as from four to eight weeks. The experiment indicates the unreliability of conclusions based on negative fecal examinations and statements as to the usual time required for the development of a parasite.

Dr Stiles presented a paper entitled "The Influence of Hookworm Disease upon the Apparent Age of Children in the Cotton Mills" There is a wide spread popular belief that many very young children are working in the mills, and that this life results in retarding their physical development and in producing what is called a typical "cotton mill child" Regarding this point, it appears from numerous observations that among the rural tenant whites, children very commonly appear to be younger than they are This is frequently due to hookworm disease retarding development A study of the real and apparent age of 42 people, part of whom were employed in the mills and part not so employed, showed that these persons appeared on an average 3 to 3 8 years younger than they actually were These cases show that the stunted growth of the "cotton mill child" is found in persons who never worked in cotton mills and in those who had never even lived in a cotton mill village All these cases were marked hookworm cases and their stunted growth was apparently due to this disease Considering these facts with other data, the conclusion to be drawn is that the "cotton mill child" like "cotton mill anemia" is a product, not of the cotton mills, but of soil pollution and of the resulting infection taking place before puberty Owing to the presence of hookworm suspects, great care is necessary in judging the ages of mill children

Even after making allowance for hookworm cases in judging ages, there are still a number of young children at work in the mills These are in some cases actually below the legal mill age limit Of 464 hookworm cases and suspects where the exact or approximate age was obtained, 19, over 4 per cent, were below the legal mill age limit (twelve years) of South Carolina, the ages running from nine to eleven years Probably the ratio of children under twelve years of age to the total number of employees is between 2 and 5 per cent

A number of the small children seen in the mills are not employed by the mills, but are "helping" their elders The parent or elder sister is paid for the amount of work turned out With the assistance of a younger brother or sister, who would otherwise be helping with the house work at home, more work can be turned out, thus increasing the earnings The employees are chiefly responsible for this form of evading the law Most mills would prefer not to have these "helpers," but if they are turned out, the family involved moves to another mill. The practise can only be stopped by legal prohibition or mill association agreement, the former being perhaps the better, as the employees resent restrictions made by the mills but accept in more or less good faith the restrictive laws

Mothers often bring children four or five years old to the mills and the children play while the mothers work Often the mother can not leave the child at home, and the kindergarten, provided by some of the mills, is not always open To refuse to allow these children in the mills would increase the difficulty of a widowed or deserted mother in supporting herself

The average child in the cotton mill family is anxious to go into the mills To this end many of them practise deception in regard to their ages

Cases probably occur where parents compel children to lie about their ages, the large number of children claiming to be just above the legal age for mill work points to this

Many of the children have no idea of their exact age and the fathers are often almost as ignorant

It seems probable that a physical examination by local or state medical officials would be better than the present age limit laws In this way many cases of disease would be detected, excluded from the mills and treated It would exclude from the mills all persons who are now justly excluded

Dr Stiles presented a second paper entitled "Is the So called 'Cotton mill Anemia' of the Gulf Atlantic States due to Lint or to Hookworms?" A common explanation of the wide spread anemia among cotton mill hands in certain portions of the United States is that it is due to "breathing in the lint" If this be true, then since the cotton, and hence the lint also, are practically identical in all parts of the country, we would expect to find (1) that the hands in the New England cotton mills show the same type and extent of anemia as those in mills south of the Potomac and Ohio Rivers, (2) that mills of a similar character in eastern, central or western parts of North or South Carolina, or in southern, central or northern parts of Georgia or Alabama, show approximately the same proportion of anemia, (3) that there is the same amount and severity of anemia in a given district among hands who are of the first, second or third generation of mill workers and removed by one, two or three generations from the farm, or if there were

any difference that the anemia would be less among the hands of the first generation, (4) that the greater proportion of severe cases of anemia will be found in such rooms as the card room where there is the greater amount of lint flying around, less severe cases in the spinning room, and no severe cases in the cloth or engine room where there is little or no lint, (5) that persons fresh from the farms will not be very anemic but will become more so the longer they work, (6) and that if the anemia is due to the lint it is not very extensive or severe in the knitting mills, the paper mills, or the orphan asylums, or among medical students or trained nurses, since the persons involved here have little or no contact with lint. Investigation shows that in a general way the contrary is true in the above assumptions.

(1) Not a single case of cotton mill anemia was found in the New England mills, although over 2,000 had been seen in the southern mills. (2) In the Carolinas, Georgia and Alabama, there is a relatively low percentage of cases of anemia in the central clay lands, a greater number of cases and more severe cases are found in places where the hands come from the sand or mountain lands, the worst cases coming from the sand lands. (3) Even where they were located in new mills with better sanitary provisions, the generation fresh from the farms showed a greater percentage of anemia than the hands who were one or two generations removed from the farm. (4) In general the cases of cotton mill anemia are more severe and frequent in the spinning room than in the card room, and the most severe case found in one mill was in the cloth room. (5) Of 59 cases, 39 per cent. had been in the mills less than a year and 61 per cent. had been there more than a year. It seems that 94 per cent. of these cases might theoretically be considered as hookworm infections persisting after removal from soil pollution, and in a number of cases of severe anemia the persons had just entered the mill. (6) The most anemia found in any establishment was in a knitting mill, where 08.8 per cent. had typical "cotton mill anemia." This same anemia was found in paper mills and colleges, and 18 cases were found in an orphanage among children who had never worked in the mills.

The above findings lead to the conclusion that the "cotton mill anemia" has nothing to do with working in the cotton mills. It is due to hookworm disease, contracted in most cases on the farms as a result of the insanitary conditions existing in the rural districts, and brought to the mills from the farms. There is less anemia among mill workers than among the farm tenants, owing to the fact that life under the improved sanitary conditions of the average cotton mill is better from the public health point of view than life as a tenant on a soil polluted farm of the sort from which so many of these people come.

Mr. Crawley presented a paper entitled "Experiments on the Transmission of Trypanosomes by *Glossina*," in which he reviewed the work of Bouet and Roubaud. These workers instituted a series of experiments with *Trypanosoma dimorphon*, *T. cazalboui* and *T. pecaudi*, and the tsetse flies, *Glossina palpalis*, *G. tachinoides* and *G. longipalpis*. It was found that any one of the three species of *Glossina* functioned equally well as host for *T. cazalboui*. Observations with the other trypanosomes have not been completed. Flies bred in the laboratory, and hence free from parasites, were permitted to feed on an infected animal and later were fed each day on a series of "clean" animals. It was found that the first feed or "infecting repast" was followed by a latent period of six days, during which the trypanosomes in the fly are innocuous. The fly then becomes infective and for some time at least the number of trypanosomes within it undergoes a progressive increase. The fly presumably remains infective as long as it lives.

An examination of the infected flies showed that the infection was confined to the proboscis. In the labrum, the flagellates are of the *Leptomonas* type and are fixed to the wall. These develop into trypanosomes which occur in the interior of the hypopharynx. They are either attached to the walls by the ends of the flagella, or free and motile in the interior of the organ. They never ascend beyond the common canal of the salivary glands, but always amass in considerable numbers in the vicinity of the opening of this canal into the hypopharynx.

These trypanosome forms appear in the hypopharynx forty eight hours after the infecting feed, and are abundant by the fourth day. The authors regard these as the infecting elements, and call attention to the fact that the incubation period is not marked by morphological changes, but rather by changes of a physiological nature as regards the virulence of the parasites.

In all, 20 per cent. of the flies fed on infected animals became infected.

MAURICE C. HALL,
Secretary

// SCIENCE

Friday, April 7, 1911

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MSS. intended for publication and books, etc., intended for review should be sent to the Editor of Science, Garrison-on-Hudson, N. Y.

THE LOST ARTS OF CHEMISTRY[1]

In addition to chronicling past and present events merely, it pleases the historian from time to time to ascertain, as nearly as he can, by a comparison of present with past conditions and present knowledge and practise with past knowledge and practise, the present condition of mankind of any particular society, in comparison with past conditions. Thus are compared present systems of government with past systems, new religious beliefs with old, modern science with ancient science, present-day arts and manufactures with those of old.

Progress never takes a straight course for any considerable length of time. Nor does it even follow an undulating course in one general direction. But there are advancements and retrogressions, repeated endlessly. And again progress as recorded by history does not represent necessarily the progress of the whole human race. On the contrary, it does not represent even a large part of the human race, but at most an isolated portion of it, and in this isolated portion the progress is recorded not of the whole but of the most advanced individuals only. When we say that the present age is one of great business, scientific and manufacturing or artistic achievements in comparison with the fourteenth century, for example, we mean that a few individuals, very few in fact compared with the total number, have contrived to bring about great results in those fields of human activity. But we must remember at the same time that the majority of indi-

[1] An address delivered before the Minneapolis meeting of the American Chemical Society, December 28, 1910.

viduals may not have been directly concerned in the advance or may not have contributed directly to it at all Indeed, it seems as though the lowest members of the human race to-day are no farther advanced mentally than were their progenitors in recent geologic times Even with rapid progress of the most favored or most enterprising individuals there may be little progress or none in the case of the average of mankind It is not unlikely that at the present day the intellectual gap between the mentally highest and lowest of mankind is greater than at any previous time

In spite of the high intellectual and practical standard reached by the leading men of to-day, from another point of view (called by some the pessimistic) the outlook to-day is far from satisfactory in politics, religion, manufacture or science Whether we consider our all but failing efforts at democracy in the United States or the vacillating and undirected religious tendencies of the people (as shown by mormonism, seventh day adventism, dowieism, christian science, the old theologies or the strange oriental doctrines and ideals of the majority of our people, which fortunately are scarcely put into practise), or if we consider the slow conservatism and plodding course of manufacture and business, including our great untouched problem of the economic distribution of goods, we can not fail to be impressed with the length of the journey which we must sooner or later take, on the road of development

But we may turn from the rather unsatisfactory consideration of politics, religion and business to the consideration of modern science with a rare degree of satisfaction and enthusiasm There, at least, progress is visible, tangible or even obtrusive There, at least, the forward movement does not take the slow, conservative, timid pace of business, nor follow the meandering, uncertain, sentimental path of religion, or the crude meaningless way of politics In that field at least the way is certain, the methods positive, the results satisfying, the application secure and the progress lively Considered by itself, science and the scientific method are the most satisfactory and satisfying things in the possession of the human mind The unfortunate thing—it can not be classed as a criticism—about science is that it has left the multitude untouched With the results of science and the scientific method on every hand forming so large a part of our splendid materialistic civilization, nevertheless the great, the overwhelming majority of people are ignorant of the methods, the aims and the results of scientific inquiry in daily use, and of daily necessity Of even greater import, the scientific method of thought is not a part of their mental equipment

Science and the scientific method have their critics, no less than other excellent things Science is unmoral, cold, heartless, pessimistic, hopeless, often cruel in method, say they The scientific inquirer can well afford to let most of such accusations as these go unchallenged But there is one statement which has been sown broadcast, which springs up in a thousand unexpected places, and which it is worth while to devote some attention to in order to refute it It is the statement that ancient peoples have been possessed of knowledge and of arts unknown to modern times, and indeed people would have us believe that this knowledge and these arts are recoverable by us if at all only with extreme difficulty The "lost arts" is the cry In so far as these so-called lost arts concern applied chemistry let us examine into them, and ascertain if posible whether or not there is truth in the assertions alluded to

In the first place we may well inquire into the origin of the wide-spread belief that the knowledge of various mechanical and chemical arts has been lost to mankind Probably first among the causes is that universal veneration of antiquity which makes gods and saints out of heroes and martyrs of the past, leads to ancestor worship and in general exaggerates the virtues, the crafts and the deeds of valor of olden times Secondly, the delight of many persons in mystery, their tendency toward belief in the mysterious, occult and miraculous, against their better judgment and the facts in the case, have great influence in originating and perpetuating the belief in lost arts Thirdly, among the more general causes, we may place vague statements or sentences which we can not accurately translate in ancient manuscripts Fourthly, the natural reaction against an egotistical age Fifthly, the use by ancient peoples for certain purposes of materials which we would not use to-day on account of their unsuitability This leads to the conclusion that the ancients knew of different and better methods of preparing the material Sixth, it has pleased certain writers and lecturers to insist strongly upon the point that there have been at various times in existence arts no longer known and used One finds brief statements in various books of such import as "they knew how to harden copper" "Their mortar outlasted the stone it cemented" "The degree of perfection they reached in enameling has never since been attained," etc In America the man who has had probably more effect than others in this respect was Wendell Phillips His lecture entitled "The Lost Arts" was first delivered in the American lyceum course in the winter of 1838 During succeeding years the lecture was repeated about two thousand times and was heard by all sorts of audiences throughout the country and at the time and subsequently made a great impression Many persons now living still remember the famous lecture It is difficult to read this lecture to-day and believe that it was seriously intended in certain places by Wendell Phillips, yet I am assured by several individuals who heard it that, although illumined by humor in places, it was, as a whole, seriously intended and received In various lectures Phillips committed many sins against accuracy and truth, but in none more than in the "Lost Arts" He misquoted Pliny in regard to his statements about the origin of glass manufacture—a tale familiar to you all and hardly rising to the dignity of a first-class fable And of all authors, Pliny can least afford to be misquoted, being already overburdened with inaccuracy and unreliability Let me present a few brief quotations from this remarkable lecture

The chemistry of the most ancient period had reached a point which we have never even approached, and which we in vain struggle to reach to day Indeed, the whole management of the effect of light on glass is still a matter of profound study

The second story of half a dozen—certainly five—related to the age of Tiberius, the time of Saint Paul, and tells of a Roman who had been banished, and who returned to Rome, bringing a wonderful cup This cup he dashed upon the marble pavement, and it was crushed, not broken, by the fall It was dented some, and with a hammer he easily brought it into shape again It was brilliant, transparent, but not brittle I had a wine-glass when I made this talk in New Haven, and among the audience was the owner, Professor Silliman He was kind enough to come to the platform when I had ended, and say that he was familiar with most of my facts, but speaking of malleable glass, he had this to say—that it was nearly a natural impossibility, and that no amount of evidence which could be brought would make him credit it Well, the Romans got their chemistry from the Arabians, they brought it into Spain eight centuries ago, and in their books of that age they claim that they got from the

Arabians malleable glass There is a kind of glass spoken of there that, if supported by one end, by its own weight in twenty hours would dwindle down to a fine line, and that you could curve it around your wrist

Cicero said that he had seen the entire "Iliad," which is a poem as large as the New Testament, written on a skin so that it could be rolled up in the compass of a nut shell Now, this is imperceptible to the ordinary eye You have seen the Declaration of Independence in the compass of a quarter of a dollar, written with glasses I have to day a paper at home, as long as half my hand, on which was photographed the whole contents of a London newspaper It was put under a dove's wing and sent into Paris, where they enlarged it and read the news This copy of the "Iliad" must have been made by some such process

Pliny says that Nero the tyrant had a ring with a gem in it, which he looked through, and watched the sword play of the gladiators—men who killed each other to amuse the people—more clearly than with the naked eye So Nero had an opera glass

So Mauritius the Sicilian stood on the promontory of his island and could sweep over the entire sea to the coast of Africa with his nauscopite, which is a word derived from two Greek words, meaning "to see a ship" Evidently Mauritius, who was a pirate, had a marine telescope

The French who went to Egypt with Napoleon said that all the colors were perfect except the greenish white, which is the hardest for us They had no difficulty with the Tyrian blue The burned city of Pompeii was a city of stucco All the houses are stucco outside, and it is stained with Tyrian blue, the royal color of antiquity

But you never can rely on the name of a color after a thousand years So the Tyrian blue is almost a red—about the color of these curtains This is a city all of red It had been buried seventeen hundred years, and if you take a shovel now, and clear away the ashes, this color flames up upon you, a great deal richer than anything we can produce

I feel reasonably sure from what I know of the history of science that the main points made in this lecture were not true in Wendell Phillips's time I know they are not true to-day

To recapitulate the causes of a belief in lost arts appear to be the veneration of antiquity, the belief in the mysterious and occult, inaccuracies in and inaccurate readings of ancient texts, reaction against present-day egotism, the use of unsuitable materials by ancient peoples and the emphasis laid upon ancient skill by half accurate writers

No one could wish to detract from the great, the skilful and the beautiful works of the ancients All we can desire is a proper and clear understanding of their accomplishments

Long before the way was prepared for an approach to chemistry as a science, many were the chemical facts known and used and many the chemical arts and manufactures which arose and flourished The foundations of many of our greatest chemical industries were securely laid long before the science of chemistry lent its aid The industries of cement and plaster, glass, ceramics, pigments, oils and fats, varnishes and lacquers, sugar, fermentation, textiles, paper, dyeing, leather, glue and various metallurgical industries are some of those which were very well developed before the advent of scientific chemistry Indeed, the science of chemistry has found and still finds some of its richest materials in these very industries What can be accomplished by patient manual skill and dexterity is amazing, and it must be conceded that the adoption of exact mechanical processes in our times has lessened the necessity for such skill in many directions It is true also that many ancient peoples and many of the less mechanical modern ones have applied manual dexterity to their arts in such a way that we marvel at the results But it is difficult to find a case where similar application to-day would not yield a similar result Nothing can be considered lost unless it be the demand for and desire to produce works of a certain kind

Again it is true that some arts and

modes of manufacture reach a stage which we may call practical perfection, relatively soon after the initial discoveries are made which give them their first impetus After this point is reached the improvements are few or none (and if any occur, they come from an outside source, as the application of power to the loom) Examples are abundant the hoe and other simple farming implements, the safety bicycle, the sewing machine, the aeroplane It must, of course, be presupposed that suitable materials for manufacture have been previously discovered and are at hand, or can be quickly adapted In such cases as these the opportunities of later generations to develop and improve are meager, but the limitation is not of the inventors, but of the things themselves

For many years the great pyramid of Egypt was held up to the youth in all lands as an example of what had been accomplished by ancient peoples and which could not be duplicated to-day It was held in fact that the ancient Egyptians were possessed of mechanical knowledge and appliances unknown to us We must all concede that the great pyramid is a remarkable, if useless, piece of architecture, laid out with extreme precision and carried to its completion in a masterly way But it turns out that the Egyptians of the Old Kingdom possessed rather limited knowledge of mechanics, not having even developed the movable pulley The great pyramid was built by man-power multiplied many thousand times Finally, can it be considered a greater work than a great railway system or battleship?

That arts have been temporarily lost at least for practical purposes is true The history of industry has not yet been written—possibly it is too great a task—and adequate data have not been collected and hence are not available, but it seems true from the information available that there has been a remarkable continuity in industrial processes in spite of many adverse circumstances

War is probably the greatest cause of breaks in the continuity of manufacturing processes and the arts of peace, and if we are to believe past records, the domination of theological systems or religious dogmatism has been and is the most effective influence in restraining the development of scientific methods of inquiry and consequently progress in the arts On the other hand, commerce and the migrations of peoples have been effective in spreading industries War destroys commerce, but often causes migrations, and hence has been an active influence in the spreading of industry as well as in checking it War has also imposed new civilizations on old, and thus caused an unnatural intercourse between two civilizations, which would naturally result in the extension of knowledge of the industries peculiar to each

Let us examine for a few moments some of the arts claimed to be now lost The knowledge of a process for hardening copper is commonly ascribed to many ancient and prehistoric peoples and is devoutly believed in by many persons Now in the first place if this knowledge was formerly possessed we have no direct evidence of it, for the copper implements which have come down to us are no harder than those we might make ourselves to-day A metal may be hardened in two ways by physical treatment or by alloying it with other metals or substances Copper may be hardened to some extent by hammering, in the same way that many other metals may be hardened The common alloys, bronze and brass, are harder than the pure metal It is probable that ancient peoples used the process of hammering to harden copper and it is certain that they made use of the

alloys of copper first with tin and later with zinc, for many purposes, including tools and implements But because copper and copper alloys were used for implements subjected to rough usage, this does not justify us in concluding that the makers had knowledge of a method for making the metal hard, durable and serviceable The simple and direct explanation is that they had no better material for the purpose at their command, just as in the bone and stone periods bone and stone were the best materials of construction available for tools and implements There is no justification for the idea that ancient peoples knew how to harden copper by means unknown to metallurgists of the present day

The ceramic arts are among the oldest known to mankind and the earliest development of them will probably remain unknown to us They had their beginnings in the bone and stone age, and were probably first practised by women, not by men The first clay vessels may have been clay-covered baskets dried in the sun—we do not know certainly From those early beginnings to the highest types of the art required the labor of many potters, numberless experiments and numberless failures We class ceramics among the chemical industries, and properly so, and yet the ceramic art originated, developed and flourished in many ages and in many parts of the earth without any thought of or aid from the science of chemistry It has always been and still is to a very large extent an empirical industry The essential difference between the pottery practise of ancient times and the most scientific practise of modern times lies in the reproducibility of bodies and glazes by modern methods And yet few chemists in the industry have the temerity to predict how a new clay or glaze will come out of the kiln The potters of long ago, by countless trials of different materials and countless failures, were able to produce certain effects, and they were able to continue the manufacture of similar wares and produce similar effects so long as they were able to obtain materials from the same sources A change of material would almost certainly mean a change in product It must not be forgotten that this same limitation affects the ceramic industry to-day to a very large extent The varieties and properties of clays are almost numberless It is true that potters of all times have been able to devise certain simple tests whereby they have been able to recognize differences and similarities in their raw materials, but these tests were usually of too crude a character to make refined distinctions Now from the very fact that ancient potters were dependent on certain sources of supply for materials to produce certain wares, it was very natural that wares made by a certain people at a certain time were not made by that people at another period, or by different peoples And such a case would probably be classified as a lost art But this can not properly be called a lost art Rather it is a case of lost materials! Given the materials, the wares could be made as at first This in fact has been the work of more recent times—to ascertain by careful analysis the nature of various bodies and glazes and reproduce them Of course the composition is not the whole secret, the heat treatment is almost equally important, and this is a matter for careful physical testing But as the result of modern research and practical experiment it can scarcely be maintained that any body or glaze exists which has not been and can not be reproduced

Glass manufacture is allied to the ceramic industry, and is probably the outgrowth of it In spite of Pliny's fable to

account for the origin of glass making, it is altogether likely that glazes and enamels were the immediate forerunners of glass. Glass manufacture had its origin in Egypt, not far from 2500 B.C. Who shall say that the natural mineral resources of the country (among them limestone, sand and alkalis) were not responsible for its origin there? It spread to the countries east and north of Egypt to Greece and Rome, to Spain, France and more recently to Saxony, Bohemia and Austria—finally over the civilized world. At the present time the data for a history of glass manufacture are probably as complete and available as that for any other of the chemical industries—and possibly more so. The ancient glasses were usually not perfectly transparent but were translucent, in some cases nearly opaque. Transparent glass and particularly transparent glass in large sheets, is a modern production. Many of the ancient glasses and those of early modern times possessed great beauty, considered from the standpoint of the fine arts, although their utility as light transmitters is low. In Greece and Rome glass was used for plates and saucers and other table ware, for pitchers and ornamental objects, as tile in pavements and walls, but scarcely at all in windows. With the advent of transparent glass the production of the translucent varieties did not expand, until finally the art languished in many countries and has but recently been revived for many decorative purposes. It should be noted that the art was never really lost, but the interest in and demand for translucent, tinted and rough-surfaced glass was low.

The dyeing industry is another which dates from the remotest antiquity and which was developed without the aid of scientific chemistry, on an empirical groundwork. However, ancient colors, largely derived from vegetable sources, were reproducible. The use of mordants was practised by many ancient peoples, particularly by the ancient Egyptians, who used them not only for fixing colors, but for producing different shades from the same dye bath. With increasing commerce between nations, new sources of dyes became available and the vegetable-dyeing practise had reached a high degree of perfection when the coal-tar dyes were brought forth in the chemical laboratory to the wonderment of mankind and the revolutionizing of the industry. It has never been claimed, I believe, that the art of dyeing with vegetable colors has been lost or not practised. But there is a strong tendency at the present time to disparage the aniline colors. It is very commonly said and accepted as true that vegetable dyes are superior to coal-tar dyes. That vegetable dyes are fast and coal-tar dyes are not. Persia has recently prohibited the exportation of rugs and fabrics dyed with anything but vegetable dyes, ostensibly to maintain her reputation in the rug industry. Who shall come forward and refute these charges, which are of course all but groundless? There are good and bad dyes, both coal tar and vegetable, and the best dyes must be skilfully used to produce good results. Let us hope that the coal-tar dyes will be increasingly appreciated, and that the time will not come when people will lament the lost art of vegetable dyeing!

But what about the cement and plaster of the ancients which outlasted the ages and even the stones which it held together? In the first place any cement or plaster which was not remarkably durable could not possibly have been preserved to this day. The ancients in various countries and at various times have been well acquainted with lime, burned clay-limestone (hydraulic lime), hydraulic cement, vari-

ous natural cements, puzzolan, and plaster Would it not be strange if among the materials used some would not be found to yield a cement of unusual strength? And if the setting process continued through the ages and conditions were such that weathering did not seriously attack it, the final product yielded would certainly be extremely hard But in any case it is certain that the weaker cements have not come down to us but have been disintegrated long ago The cement which is being made in enormous quantity to-day under scientific control will probably outlast any similar material which the world has seen

But we may go a step farther in our inquiry after relegating the "lost arts" to the same mythological museum which holds the lost Atlantis Not only is it unlikely that there are any "lost" chemical arts, but it is highly probable that ancient peoples were ignorant of many arts attributed to them, and which are well known at the present day Such a misunderstanding could probably best be dispelled by a carefully compiled history of arts and manufactures, particularly ancient arts and manufactures The production of such a book is a consummation devoutly to be wished

I have an idea that it is not a difficult matter to gain a mental picture of conditions in ancient workshops I believe that the mental attitude of artisans has not changed much during the lapse of hundreds or even thousands of years Go into any small shop at the present day where a specialized art or craft is practised and I fancy that you will find the workers there in all essential respects, so far as their craft is concerned, like the craftsmen of distant ages You will find there the same lack of organized knowledge, the same sort of unnecessarily detailed, and elaborated empirical knowledge, the same narrow conservatism and adherence to formulæ and rule-of-thumb methods If you talk to the men you may learn how they learned their craft, of the most skilful members of the craft they have known, if you gain their confidence they may tell you of their past experiments (most of them foredoomed to failure) and of future experiments planned, when time permits or when they obtain material possessed of certain hypothetical properties And you will be impressed by the way results are sometimes accomplished in spite of the use of the clumsiest mental and physical methods of experiment imaginable A typical craftsman will experiment with all the materials he can lay hands on without the slightest scientific consideration of the case, in an effort to produce a certain result These things are interesting and we must hope they will never be altogether lost But our ideal for the present and the future must be a large and adequately organized industry, resting firmly on engineering skill and chemical investigation, operating with a full understanding of all its processes and with assurances of consistent and logical future development and expansion

W D Richardson

THE ELIZABETH THOMPSON SCIENCE FUND

The thirty-sixth meeting of the board of trustees was held in Boston, Mass, on February 10, 1911

The following officers were elected

President—Edward C Pickering
Treasurer—Charles S Rackemann
Secretary—Charles S Minot

Reports were received from the following holders of grants, and were accepted as reports of progress Grant 98, J Weinzirl, 109, A Nicolas, 111, R Hurthle, 119, J P McMurrich, 121, A Debierne, 123, E C Jeffrey, 131, F W Thyng, 133, J F Shepard, 137, C

H Eigenmann, 140, K E Guthe, 144, G A Hulett, 146, M Nussbaum, 149 P A Guye, 150, C A Kofoid, 152, W D Hoyt, 154 J P Munson, 155, H P Hollnagel, 156, R Thaxter, 157, L Mercier, 158, H V Neal

The secretary stated that during the past year no reports had been received from grants 22 and 27, awarded in 1889, 117 (1905), 124 (1905), 142 (1908), and 147 (1909) Grants 107 and 134 were withdrawn, since the recipients were unable to carry on the work for which the grants were awarded, and had repaid the total amount of the grant It was voted to close the records of the following grants, since the work had been satisfactorily completed, and the results published 138, Mme P Šafařík, 141 J T Patterson, 148, C C Nutting, 159, B M Davis, 160, L J Henderson, and to close upon receipt of publications the following 136, H Z Kipp, 161, O von Furth The secretary reported that additional publications had been received from W Dobeick (Grant 153), and from J Koenigsberger (Grant 139), making a total of six publications aided by this grant

An unusually large number of applications was received, and the trustees regretted that they were obliged to decline several which were highly deserving of aid

It was voted to make the following new grants

162 $200 to Superintendent O H Tittmann, Coast and Geodetic Survey, Washington, D C, for observing variations of latitude by means of a photographic zenith tube

163 $200 to Professor R L Moodie, University of Kansas, for phylogenetic studies of Amphibia

164 $200 to Professor J M Aldrich, University of Idaho, for a study of invertebrates, especially insects, found in and about the western salt and alkaline lakes

165 $150 to Professor M E Haggerty, Indiana University, for the study of instinctive reactions in newly born dogs of various breeds, and of the inheritance of those reactions

166 $200 to Professors F C Blake and C Sheard, Ohio State University, for verification of the Kirchhoff Abraham generalization of the Thomson formula for the discharge of a condenser

167 $150 to Dr E Rohde, Heidelberg, Germany, for studies of the metabolism of the mammalian heart

168 $125 to Dr H Freundlich, Leipzig, Germany, for a study of the kinetics of the transformation of aliphatic to aromatic compounds

169 $150 to Professor G A Hulett, Princeton University, for further studies of the electrochemical equivalent (in continuation of Grant 114)

It was voted that grants shall not be made for the purchase of books or ordinary laboratory apparatus, or for living expenses, or for appointments essentially similar to scholarships or fellowships It was voted to request but not to require that all applications shall be type-written

CHARLES S MINOT,
Secretary

HARVARD EXCHANGE OF TEACHERS WITH COLLEGES IN THE MIDDLE WEST

HARVARD UNIVERSITY has arranged an annual exchange of teachers with four of the colleges in the middle west—Colorado College, of Colorado Springs, Colo , Grinnell College, formerly Iowa College, of Grinnell, Ia , Knox College, of Galesburg, Ill and Beloit College, of Beloit Wis Every year, until the arrangement is terminated, Harvard University is to send a professor who will spend an equal portion of half an academic year with each of the four colleges mentioned above, and during that time will give to the students of these institutions such regular instruction in their courses as may be arranged by their faculties The salary of this professor will be paid by Harvard University His traveling expenses will be borne by the four colleges already referred to, and each of them will provide his maintenance while he is in residence The professor will be selected every year by Harvard University, with the approval of the cooperating colleges, and he will go in the first or second half-year, as may be agreed In return, each of the four colleges is expected to send to Harvard University each year one of its younger instructors for half a year, and during that time he will be appointed an assistant in some Harvard course, he will teach

and will be paid as though he were a regular member of the Harvard University staff. Unless by special agreement, he will not be required to give more than one third of his time to teaching, and may devote the rest of it to graduate and research work in any of the departments of the university. Each college is to notify Harvard University of the appointment as early as possible in the preceding year. The arrangement will go into effect in the academic year 1911–12. The first professor of Harvard University to take part in this exchange will be Albert Bushnell Hart, Ph.D., LL.D., Litt.D., Eaton professor of the science of government. His term of service will fall in the second half-year.

SCIENTIFIC NOTES AND NEWS

MR. SAMUEL FRANKLIN EMMONS, eminent for his contributions to the scientific study of ore deposits, died of asthma on the morning of March 28, at his home in Washington, D. C., aged seventy years. On the afternoon of March 30, the members of the United States Geological Survey united in a short memorial service in appreciation of his character and work.

DR. THEOBALD SMITH, professor of comparative pathology in Harvard University, has been appointed visiting professor at the University of Berlin, for the second half of the academic year 1911–12.

PROFESSOR EDWARD L. MARK, director of the Harvard Zoological Laboratory, has been elected a foreign member of the Königlichen Böhmische Gesellschaft der Wissenschaften in Prague.

DR. LAZARUS FLETCHER, F.R.S., director of the British Museum (Natural History), has been elected an honorary fellow of University College, Oxford.

DR. C. G. ABBOT, director of the Astrophysical Observatory of the Smithsonian Institution, will this summer conduct an expedition to southern Mexico to make measurements of the sun's radiation, which will be compared with simultaneous observations on Mt. Wilson. The congress has made a special appropriation of $5,000 for this work.

PROFESSOR HIRAM BINGHAM, of Yale University, will on June 10 leave for a six-months' expedition to Peru. He will be accompanied by a geologist, a topographer and a naturalist and it is hoped by a pathologist. He expects to explore the seventy-third meridian from the Amazon Valley to the ocean.

DR. ROLAND B. DIXON, of Harvard University, is spending the second half of the academic year in the Bureau of the Census in Washington, devoting himself to a statistical inquiry in regard to the Indians.

MR. WILLIAM S. KILNHOLZ has been appointed director of a marine biological laboratory located at San Pedro, Cal. This laboratory is in connection with the Los Angeles schools and the city of Los Angeles expects to spend ten thousand dollars for the laboratory during the next two years.

DR. MARIE C. STOPES, lecturer on paleobotany in the University of Manchester, and Dr. R. R. Gates, of the Missouri Botanical Garden, who met at the Minneapolis meeting of the American Association for the Advancement of Science, were married at Montreal on March 18.

THE April meeting of the American Mathematical Society will be held at University of Chicago on Friday and Saturday, April 28–29. At this meeting Professor Maxime Bôcher will deliver his presidential address, the provisional title of which is "Charles Sturm's Published and Unpublished Work on Differential and Algebraic Equations." Except for the summer meetings, this will be the first united meeting of the whole society since 1896.

DR. S. WEIR MITCHELL delivered the last lecture of the season before the Harvey Society on Saturday evening, April 1, at the New York Academy of Medicine. The subject of the lecture was "William Harvey, the Discoverer of the Circulation of the Blood."

PROFESSOR A. A. NOYES, director of the Physico-chemical Research Laboratories at the Massachusetts Institute of Technology, recently made an address before the College of Science of the University of Illinois, in

which he outlined the research work in progress at the Massachusetts Institute as well as the general policy of the department

Professor Svante Arrhenius, of Stockholm, delivered a lecture before the Scientific Association of the Johns Hopkins University on the evening of March 21 on "The Laws of Adsorption" In this lecture Arrhenius gave an account of some of his recent work in this field

Dr Victor Goldschmidt, professor of crystallography at the University of Heidelberg, has visited the University of Michigan and has given several lectures before classes in mineralogy and geology

Professor W H Freedman, of Pratt Institute, Brooklyn, lectured at the University of Vermont on March 27 on "Some Recent Engineering Achievements," and on March 29 on "Wireless Telegraphy"

Dr Henry P Bowditch's books and scientific apparatus and the sum of $4,000 are bequeathed to Harvard College for the Medical School by the provisions of his will The bequest of $4,000 is "to be added to the fund left by my father, J Ingersoll Bowditch, the income of which shall be expended under the direction of the professor of physiology for the purpose of original investigation"

A bronze tablet in honor of Albert Benjamin Prescott, formerly director of the Chemical Laboratory of the University of Michigan, was put in place at the entry of the new chemical building at the university on March 15

Mrs Ellen Henrietta Swallow Richards, instructor in sanitary engineering in the Massachusetts Institute of Technology, well known for her valuable contributions to sanitary problems, has died at the age of sixty-nine years Mrs Richards was the wife of Dr Robert H Richards, professor of mining engineering at the institute

Edward Fitch Cushing, Ph B (Cornell, '83), M D (Harvard, '88), one of the foremost physicians and public men of the city of Cleveland, died on March 23, at the age of forty-nine years He had practised medicine in Cleveland for the last eighteen years and was professor of the diseases of children in Western Reserve University Dr Cushing was the fourth of his family to follow the medical profession His great-grandfather was a physician in New England, his grandfather, Erastus Cushing, and his father, Henry Kirke Cushing were both physicians in Cleveland His brothers are William E Cushing, a lawyer and trustee of Western Reserve University, Henry P Cushing, professor of geology in Western Reserve University, and Harvey Cushing, professor of surgery in the Johns Hopkins University

At a special meeting lately held in the Berlin Royal Museum of Natural History, as we learn from *Nature*, the committee for the exploration of the dinosaur-bearing deposits of German East Africa exhibited a few of the more remarkable specimens already received The collection consists chiefly of the remains of Sauropoda, some much larger than the gigantic species of North America One humerus measures more than two meters in length, and some of the cervical vertebræ are twice as large as those of Diplodocus The leader of the exploring party, Dr W Janensch, reports the discovery of two new localities in which dinosaurian bones are abundant

The Paris Academy of Medicine, which, in deference to the representations of the British government, recently agreed to designate the disease known as Maltese fever by the term "Mediterranean fever," has decided to adopt as its scientific appellation the name *Melitococcie*

Mrs John H Caswell, of New York, has presented to Trinity College the valuable collection of minerals gathered during his lifetime by the late John Henry Caswell Mr Caswell was graduated from Columbia University in 1865, and after three years' study in Germany became assistant in mineralogy in the newly organized Columbia School of Mines In 1877 his business interests compelled him to give up the career of a scientific man, but he maintained his interest in mineralogy, and his collection became valuable It contains about 4,000 specimens scientifically arranged and illustrates very completely the

typical crystal forms and their variations for a large range of mineral species

That 126 persons bitten by rabid animals in Wisconsin have been treated during the past fourteen months at the Pasteur Institute established in connection with the hygienic laboratory at the University of Wisconsin, is shown by the report of Dr M P Ravenel, the director Over 170 animals supposed to have suffered from hydrophobia were examined by the experts at the laboratory, and the spread of the disease has been checked to a great extent The patients treated came from 61 cities and towns in the state Six persons are under treatment at the present time at the laboratory The entire Pasteur treatment is given the patients at a cost of $25, about one fourth the cost at institutions not conducted by the state Funds are being asked the present legislature sufficient to allow the laboratory to administer the treatment free of charge

The production of natural gas in the United States in 1909, as ascertained by a joint canvass made by the United States Geological Survey and the Bureau of the Census, is estimated by B Hill, in charge of this work, under the supervision of D T Day, to have been $55,000,000, an increase of only about $359,626 over that of 1908 There were no great changes in the industry during the year, the production continuing to decline in Kansas, and an increase being made in Oklahoma and in the Caddo field in Louisiana and in Texas An interesting feature was the supplying of Fort Worth and Dallas from the gas fields of Clay County, Texas For the year 1910 the total production is estimated at $57,000,000, an increase of about $2,000,000 over 1909 During 1910 a feature of great interest was the development of what promises to be a very large supply of natural gas in the Buena Vista Hills, Kern County, Cal, east of the Sunset-McKittrick oil field Arrangements were made and practically completed during the year for piping this gas to Bakersfield and other towns in San Joaquin Valley

An International Congress of the Applications of Electricity is to be held in Turin, Italy, on September 9–20 *Nature* states that this congress, as its title implies, will deal with questions of practical import, so that electrical engineers will be able to participate largely in the discussions The chief endeavor of the organizing committee, which is under the chairmanship of Professor Luigi Lombardi, has been so to draw up the program that the congress may be international in character as well as in name To attain this object, the cooperation of the International Electrotechnical Commission, with its local committees now established in many countries, has been obtained, as well as the assistance of the societies and associations in all countries dealing with electrical matters With the help of these organizations, official reporters have been selected, and already many assurances have been received that numerous papers will be presented to the congress from all parts of the world The initiators of the congress are the Italian Electrotechnical Society and the Italian local committee of the commission mentioned above The congress is under the patronage of the Duke of the Abruzzi, who is the president of the committee of honor, upon which Professor Elihu Thomson and Colonel Crompton, the president and honorary secretary respectively of the commission, have been elected members Papers may be presented in French, English, German and Italian, and the discussions will be carried on in all these languages

The annual meeting of the British Medical Association will be held in Birmingham from July 25 to July 28 The president this year is Dr H T Butlin, consulting surgeon to St Bartholomew's Hospital, and the president-elect Professor Robert Saundby, professor of medicine in the University of Birmingham The president will deliver his address on Tuesday, July 25, the address in medicine will be given on July 26 by Dr Byron Bramwell, president of the Royal College of Physicians of Edinburgh, and the address in surgery on July 27 by Professor Jordan Lloyd, of Queen's Hospital, Birmingham For the purposes of the scientific business of the meeting sixteen sections have been authorized by the council

The subjects to be dealt with and the presidents in each section are indicated below

Anatomy and Physiology—Professor T H Bryce, Glasgow

Dermatology—Dr James Galloway, London

Diseases of Children—Dr Otto Kauffmann, Birmingham

Electro therapeutics and Radiology—Dr Hugh Walsham, London

Laryngology, Otology and Rhinology—Mr Frank Marsh, F R C S, Birmingham

Medical Sociology (including medical inspection of school children, hospital administration, and contract practise)—Dr George Reid Stafford

Medicine—Dr Alfred Carter, Birmingham

Neurology and Psychological Medicine—Dr Edwin Goodall, Whitchurch, Cardiff

Obstetrics and Gynecology—Professor Edward Malins, Birmingham

Odontology—Professor Frank Huxley, Birmingham

Ophthalmology—Mr Henry Eales, M R C S, Birmingham

Pathology—Professor R F C Leith, Birmingham

State Medicine and Industrial Diseases—Professor A B Hill, Birmingham

Surgery—Sir T F Chavasse, Birmingham

Therapeutics, including Dietetics—Sir Robert Simon, Birmingham

Tropical Medicine—Sir Francis Lovell, London

The department of forestry at the University of Montana proposes to organize a summer cruise for students of forestry The party will probably start from Missoula, about July 1, for a tour of the western forest regions, visiting the best stands of timber, viewing the operations of the Forest Service on the national forests, such as timber-sales, planting, reconnaisance, etc, also the operations of private concerns in logging and milling Lectures on different phases of forestry will be given at appropriate points The regions visited will include the northern Rocky Mountains, Puget Sound, the sugar pine country of southern Oregon and the redwood belts of California A feature of the work will be the opportunity afforded for acquiring experience in camping, riding and packing, and familiarity with western conditions The course will continue for about six weeks, and will be open to a limited number Those interested should address Professor J E Kirkwood, University of Montana, Missoula The winter school for forest rangers at the University of Montana has just concluded its second session An extension of the course is contemplated covering two years during the winter seasons Courses are given in various phases of forestry as related to the administration of national forests The staff of instruction includes part of the university faculty and officers of the Forest Service

We learn from *Nature* that a plan for the establishment of an Institute of Technical Optics has been approved by the education committee of the London County Council, and will shortly come before the council The object of this scheme is the establishment in London of an Institute of Technical Optics for the training of opticians and optical instrument makers, and it is also hoped that valuable work may be done in connection with investigations in optical glass The education committee proposes that the council shall grant £35,000 for the building and equipment of the new institute, the site, valued at about £12,000, having been already provided by the Northampton Polytechnic Institute, under the direction of the governors of which the new institute will be maintained To ensure that the work shall be on the best lines, it is proposed to appoint a consultative committee representative of the trade, scientific and other organizations interested The new institute will be maintained from funds at present used to maintain the technical optics department of the Northampton Polytechnic Institute, additional grants from the Board of Education and additional contributions from the London County Council Later it is hoped that, in view of the national character of some of the work which may be developed, assistance may also be obtained from imperial funds In the proposals under consideration, provision is made for the teaching of optical science with its technical applications, and of other subjects of value to the manufacturer and designer of optical instruments, and to the optician

A NEW list of publications of the United States Geological Survey, just issued, contains the titles of more than a thousand books and pamphlets. These reports cover a wide range of subjects. They include not only papers on geology and topography but reports on water resources and on technology. The Geological Survey was the nursery of the United States Reclamation Service and the Bureau of Mines, which now, in full growth, are carrying along successfully work begun by the survey years ago. The survey, however, still continues its work on water resources and includes discussions of technology in its annual volume "Mineral Resources of the United States." A glance at this list will show the great diversity of the subjects considered and the manifold nature of the science of geology. The reports include discussions of geologic chemistry, mineralogy, petrography and paleontology, as well as ore deposition and other matters of very practical importance. Much of the survey's late work has been directed to the study of mineral deposits of economic value. The work done in land classification has not yet found detailed expression in the survey's reports, but some papers prepared as a result of land-classification surveys have been printed annually in bulletins entitled "Contributions to Economic Geology." The list may be obtained by applying to the director of the survey at Washington, D. C.

The statistics of production of gems and precious stones in the United States in 1909, which were collected by the Geological Survey and the Bureau of the Census and have just been published, show a large increase in value over 1908. The total value in 1909 was $534,380, the value in 1908 was $416,063. The increase is due chiefly to larger outputs of turquoise, tourmaline, variscite, chrysoprase, californite and kunzite. The production of a number of precious stones—as beryl, garnet, peridot and topaz—showed a decrease in value. The output of turquoise matrix and turquoise amounted to over 17 tons, that of variscite to over 3½ tons and that of tourmaline to over 2¾ tons. An account of the occurrence and production of gem materials in the United States, with notes on the precious stones industry, has just been published in pamphlet form by the Geological Survey in an advance chapter from "Mineral Resources of the United States, Calendar Year 1909." The pamphlet, entitled "The Production of Gems and Precious Stones in 1909," was prepared by Douglas B. Sterrett and may be obtained free by applying to the director of the survey.

UNIVERSITY AND EDUCATIONAL NEWS

THE legislature of Missouri has recently made appropriations for the state university which include $100,000 for a new laboratory of physics and $60,000 for a laboratory of agricultural chemistry. A building for veterinary science is now in course of construction at a cost of over $30,000. In the recent appropriations the amount appropriated for salaries and current expenses exceeded that of two years ago for similar purposes by $152,000. This amount will be mainly devoted to the increasing of salaries and the enlargement of the faculty.

AN anonymous donor has given Oberlin College the property fronting on South Professor Street in Oberlin, known as the Johnson estate. This comprises approximately twenty-two acres, and is valued at from $35,000 to $40,000.

BY the will of Mrs. Amelia Worthington, of Boston, widow of Bishop Worthington, of Nebraska, a bequest is made to Williams College amounting to $30,000, dependent upon certain contingencies.

MESSRS. MALLINCKRODT, of St. Louis, Mo., announce that they will pay a prize of $500 to a chosen student of chemistry in the Graduate Schools of Harvard University during the academic year 1911–12, on condition that he will serve in the Mallinckrodt Chemical Works in 1912–13 at a suitable salary.

TRINITY COLLEGE has given Cambridge University the sum of £1,000, which is to be used toward the erection of buildings for physiology and for experimental psychology.

THE University of Manchester has received an anonymous gift of £1,000 for promoting research work in medical subjects.

By vote of the board of trustees it was decided last year that at the close of the school year 1911 the academy of the University of Illinois, which has existed since 1876, should be discontinued. Mr. J. P. Gilbert, who was an instructor in zoology, has just been elected head of the department of biology and agriculture in the Southern Illinois Normal at Carbondale. Another member of the academy force, Mr. S. E. Boomer, goes also to the Southern Illinois Normal as head of the mathematics department.

Dr. Hans Zinsser has been promoted to be professor of bacteriology in Stanford University.

The School of Engineering of the University of Pittsburgh announces a new course in mechanical railway engineering which will be under the direction of Mr. D. F. Crawford, general superintendent of motive power, Pennsylvania lines west of Pittsburgh. Students working in this course will combine their theoretical course with practical work in connection with the Pennsylvania lines west of Pittsburgh.

The Bryn Mawr European fellowship has been awarded this year to Miss Helen Tredway, who specialized in physics and chemistry, the president's European fellowship to Miss Mary E. Pinney in biology, and the Mary E. Garret European fellowship to Miss Margaret E. Brusstar, in mathematics.

DISCUSSION AND CORRESPONDENCE

THE ACOUSTICAL ENGINEER

The subject of acoustics as applied to auditoriums deserves a much greater interest on the part of physicists and architects. It is not just, however, to offer criticism without considering some of the reasons for this lack of attention. The physicist realizes that there are many practical problems which constantly tempt him to turn from the performance of his proper function. Moreover he knows that physicists (Sabine and others) have already obtained results far in advance of what are actually utilized by architects to-day. On the other hand, the architect is a man of many troubles and is therefore not inclined to add to his cares by indulgence in experimental work or by applying Sabine's formula to a proposed auditorium. His fee does not cover such expert work and he very naturally attempts to do well that for which he is paid. In short, there is not a sufficient incentive for active interest on the part of either the physicist or the architect.

In spite of the excellent work that has been done, particularly by Sabine, our knowledge of the subject of architectural acoustics is quite limited. It is true (although doubted even by some physicists) that one can not only correct excessive reverberation of an auditorium already constructed, but he can even compute what effect will be had in a proposed structure. This, however, is only a small part of the achievement that will some day be possible. Again our methods of correcting excessive reverberation are not entirely satisfactory either to an architect, or to a layman who desires the remedy to be both permanent and sanitary. It is not for the physicist to improve our present methods of remedying excessive reverberation for this is a practical problem involving structural knowledge. Neither can he be expected to think of the problems of theoretical interest which will sooner or later confront one engaged in applied acoustics.

It seems, then, that the future progress of the subject of acoustics as applied to auditoriums rests in a very large measure upon the activity of what might be termed the "acoustical engineer." This engineer must be an architect of scientific training—one who will be interested alike in the architectural and scientific aspects of the problems. Generally speaking, each auditorium needs a slightly different study and one who is to succeed must have sufficient scientific interest and ability to make the necessary investigations. As so well known, absorbing material applied to the proper area of surface will correct for excessive reverberation. But the amount of area that can be utilized, the character of the interior finish, etc., enter into the

problem. The absorbing material applied should be tested experimentally so that the area covered will give a satisfactory result. Moreover, in cases of well-defined echoes each auditorium will probably require more detailed study.

There are an increasing number of architects in this country who are actively interested in the subject of architectural acoustics, but, with one exception, they have not devoted much time to experimental investigation. This exception is an architect who is devoting his entire time to acoustical engineering. On the other hand, the public does not realize the present knowledge on the subject of architectural acoustics and the architect does not make a serious attempt to educate. The purpose of this note is to call the attention of scientific men to the acoustical engineer and to urge their active interest so far as the education of the public and the recognition of the need of such a consulting engineer are concerned.

G. W. STEWART

THE STATE UNIVERSITY OF IOWA

ACADEMIC EFFICIENCY

TO THE EDITOR OF SCIENCE: Since on several occasions there have appeared in SCIENCE certain criticisms of the Cooke report of the Carnegie Foundation, I hope that you may be willing to publish a brief statement of an opposite view.

Both the report itself and its introduction by Dr. Pritchett state clearly that the opinions of an "outsider" were considered desirable. The recent criticisms of collegiate conditions by many who have not actually studied at first hand the things they condemn seem to have led to the investigation upon which the report is based.

Most of the opinions set forth in the report are precisely those which any well-informed person not connected with a college would hold after a similar study of what actually exists. Moreover, not a few persons on the inside of the college world hold quite similar views. In some ways certain of us go even farther in condemning a part of the things that are more or less characteristic of the college life of to-day.

Especially in trying to fit young men to meet successfully the practical conditions of the real business world, we lament most deeply the woeful lack of the "snap and vigor" which Mr. Cooke found wanting in most of the institutions visited. The "lack of intensiveness" appeals to us much more as a hindrance to the proper preparation of our students for what we know will be required of them in the near future than for any other reason. Not a few of those who employ many highly trained workers positively condemn the college graduate, and will not hire him until he has been whipped into line by sufficient practical experience after his graduation. Some of us know that this is not on account of the subjects which we teach or do not teach in our courses, but rather on account of the general attitude of many of our graduates toward the work that may be assigned them. During the first half year of the cooperative system at the University of Cincinnati, Dean Schneider says he was frequently called to his telephone to listen to something similar to this: "That cub you sent down here thinks this is a university. He won't work." Far too many young men in the colleges and in the collegiate departments of the universities "won't work." Too many students in all of our institutions have no proper conception of the real economic value of their own time or of the opportunities within their grasp. Such ones do not make efficient use of what is provided for them, in funds and in equipments of various kinds. They cut class and laboratory exercises without adequate reasons. They try all kinds of schemes to get out of regular and systematic work. They neglect to do many of the things assigned to them, in many cases up to what they consider the very lower limit of a bare passing grade. Sometimes they ask if they can "cut" this or neglect that and still have a chance to "pass." They give time, energy and most of the thinking that they do, to things which can not be of the least permanent value to them in later life.

Such students do these and many other

things which in the commercial world would not be tolerated for a single day. Some colleges have a much greater proportion of this kind of students, but all colleges have far too many. It is certainly not logical to say that the work of the colleges is so admirable in some respects that the undesirable should be overlooked.

The colleges continually appeal to the public for money and for students. Then why is not this public entitled to consider all phases of college administration and college work? It is considered wise to examine all sides to other questions, and to give the proper relative weight to all things involved. Why should the college question demand a special kind of treatment? Whether instructors and students accomplish as much as they might with the facilities available and with the funds expended is not by any means unimportant. Unless we can claim exemption from any form of criticism, we have no grounds for objection to criticism here.

However true it may be that other things connected with the work of the colleges are more important than those discussed in the Cooke report, no convincing reasons have been given, nor can be given, to show that the bad in our college system can not be improved without the least detriment to the good. In fact to improve in one line must naturally tend to improve others also. To waste time and money will not help any student to become a great scientist or a good citizen. A long tedious and expensive investigation is more likely to bear fruit in the hands of one who has some idea of the value of his own time and the other things he employs. The dilettante in science hinders its progress more than he helps.

I can not see how improvement in the business management of our colleges or improvement in the quality of our student body by sending home those who will not do a reasonable amount of work, or improvement in other lines that might be mentioned, can in the least do other than "tend to assist those conducting these institutions and their students towards the attainment of their own highest ideals in scholarship, character development and culture."

B. B. BRACKETT

BROOKINGS, S. D.,
February 21, 1911

LABORATORY TABLE TOPS

TO THE EDITOR OF SCIENCE: In SCIENCE for February 17, 1911, I notice a short discussion of suitable material for laboratory table tops. Having just found something quite satisfactory, which, so far as I know, is new, the mention of it may be of interest.

The table I have recently tried has a hexagonal top approximately six feet in diameter. The substratum is of pine seven eighths thick and of pieces cross-joined. This substratum is overlaid with a three eighths cover of "asbestolith," a composition of asbestos and cement. This cover of asbestolith was infiltrated with paraffin. To hold the cover the substratum was partially bored to supply small holes which were filled with the asbestolith. This asbestolith is laid on like cement and hardens. It can be made to cover the edge of the top so that the top has the appearance of a solid slab. This top has an absolutely continuous surface, a high degree of resilience, is acid and alkali proof, and can be repaired at any time to original form. The only effect of heat is to melt the paraffin, but this has not proved a serious objection, as it can always be rubbed down to look well. The work was done for me by the Waco Cement Company but no doubt can be duplicated almost anywhere.

RAYMOND H. POND

EXPERIMENT STATION,
COLLEGE STATION, TEXAS

TOTEMISM

IN SCIENCE for February 17 there appeared a report of a paper on "The Totemic Complex" read by myself at a meeting of the Anthropological Society of Washington, on January 17, 1911. I wish to correct some statements made in that report, which might prove misleading. The beginning of the study of totemism does not date back to the sixteenth but to the later half of the nineteenth century. The various features of totemism (exogamy,

tabu, animal descent, etc.), although "they exist separately and independently from one another," are also found associated in totemic complexes. If they were "nowhere found united" and were "not correlated to one another" there would be no totemic problem.

A. A. GOLDENWEISER

February 23, 1911

EVIDENCE OF THE ZEBRA IN THE PLEISTOCENE FAUNA OF FRANCE

FROM certain drawings by paleolithic artists, reproduced by Édouard Piette in his work on "The Art Relating to the Reindeer Age,"[1] it would appear that a species of zebra had wandered northward, with other members of the African fauna, during the Pleistocene, at least as far as central France. On plate XXX of Piette's work are reproduced two engraved figures of an animal that seem undoubtedly intended to represent a zebra. In one of these (Fig. 6) only the head and neck appear, while in the other (Fig. 7) almost the entire animal is drawn. The reference to these figures in the accompanying text is as follows:

FIG. 6. Engraving representing the head and neck of a horse like animal with erect mane, delicately striped like the zebra. The stripes are formed by rows of points almost contiguous. One notices in the front of the head a series of marks like chevrons and under the neck, two short parallel stripes. Grotte des Espélungues, A'Arudy.

FIG. 7. Engraving representing an animal like a horse, delicately striped like a zebra, with erect mane, small head having small ears. The stripes are indicated by series of parallel lines or of points. The tail is incompletely drawn. Grotte de Tayngen.

The striping of the hind quarters in Fig. 7, suggests the "gridiron" pattern on the rump of the rock or berg zebra (*Equus zebra*), an existing species now on the verge of extinction, but formerly abundant in the mountainous districts of Cape Colony. Here, however, the likeness ends, for the absence in the engraving of stripe marks on the limbs, the presence of which, clear down to the hoofs, is a character of the above species, would suggest Burchell's zebra (*Equus Burchelli*) as would also the small size of the ears.

[1] "L'Art Pendant L'Age Du Renne," Paris, 1907.

A careful study of these drawings forces one to the conclusion, it seems to me, that a species of zebra was present in western Europe when paleolithic men were engraving the lineaments of reindeer, bison, horse, mammoth, cave bear, woolly rhinoceros and other animals of that strange and interesting time. Surely this ancient artist did not stretch his imagination to so accurately delineate the stripe pattern of a zebra, without having seen it. All of these paleolithic engravings depict an animal most faithfully, even, at times, to minute details. The familiar sight of some beast begat an impulse that found its expression in virile representations of form, remarkably accurate considering the rude and primitive implements for engraving, that were in the hands of these artists of the remote past.

I am not aware of any previous reference to the zebra's former existence in Europe, and I present the above facts simply as evidence coming from the hand of one who without doubt knew and drew some form of zebra that later, like so many other great mammals, vanished from the northern lands.

SPENCER TROTTER

SWARTHMORE COLLEGE, PA.,
February 14, 1911

SCIENTIFIC BOOKS

Termitenleben auf Ceylon, Neue Studien zur Soziologie der Tiere, zugleich ein Kapitel Kolonialer Forstentomologie. Von KARL ESCHERICH. Jena, Gustav Fischer. 1911. Pp. xvii + 262. 68 text-figures, 3 pls.

This important contribution to our rapidly increasing knowledge of the termites, or "white ants," had its origin in a journey made by Professor Escherich during 1910 to Ceylon, and contains a very interesting account of the behavior of several of the species of that island. Four fungus-growing species (*Termes obscuriceps, redemanni* and *ceylonicus* and *Microtermes globicola*) are considered at length in the opening chapter of the work, their architecture and fungus-gardens being

described in detail and with a number of striking illustrations. The fungus (*Volvaria eurhiza*) which is cultivated and eaten by *T. redemanni* is described and figured in accordance with Petch's investigations published in 1906 in the *Annals* of the Royal Botanical Gardens of Peradenyia.

One of the most interesting portions of this chapter deals with social symbiosis, or the tendency of two species of termites or of termites and ants to inhabit the same nest. Thus Escherich often found *Termes ceylonicus* and *obscuriceps* in the same termitarium but each species inhabited galleries of its own, and although these were mingled they did not inosculate and the two species, when the nests were undisturbed, were always separated from one another by masonry walls. If the insects of the two colonies, however, were made to meet through a breaking down of the walls, their behavior towards each other was decidedly hostile and bitter conflicts ensued.

Singularly enough each of these species had its own fungus-gardens, the chambers containing which were seen to be intermingled when the termitarium was sectioned. Escherich believes that *T. obscuriceps* is the original architect of the nest, whereas *T. ceylonicus* is merely a "Raumparasit." Another case of similar symbiosis is furnished by *Capritermes ceylonicus* and *incola*, each of which may inhabit the nest of *T. redemanni* or *obscuriceps*. In this case, also, the *Capritermes* inhabits small burrows of its own in hills built by the *Termes* and violently attacks the latter whenever it is encountered. The *Capritermes* soldier has extraordinary asymmetrical mandibles by means of which it can jump into the air or hurl its enemies away from the battlefield. Other species, which Escherich found nesting in the mounds of *T. obscuriceps*, are *Leucotermes ceylonicus*, *Eutermes escherichi*, *Eurytermes assmuthi* and *Hamitermes quadriceps*. In all cases these lived shut off from but in very close proximity to their hosts and were always inimical to the latter when the two species were brought together. *Hamitermes*, *Leucotermes* and *Eurytermes* may, however, live in independent nests. Speaking in myrmecological terms, the author concludes that "all the phenomena which we ascertained regarding the living together of different termites belong without exception in the category of 'compound nests,' as opposed to 'mixed colonies.'" Concerning the relations of ants and termites he says that in Ceylon there is scarcely a termitarium which does not harbor ants. The commonest species are *Camponotus rufoglaucus* and its subspecies *paria* and *C. sericeus opaciventris*. These usually inhabit the outer walls or "Mantelregion" of the nest. Escherich was quite unable to observe any such relations as Wasmann has described as existing between South American termites and *Camponotus termitarius* and has called "phylacobiosis" on the supposition that the ant stations itself at the nest-entrance and defends its termite hosts from their enemies. Another common ant in the Cevlonese termitaria is the tropicopolitan *Plagiolepis longipes*, "which lives in nearly every mound, or at least in its immediate neighborhood, flitting like a shadow over the opened portions of the nest and rushing into the galleries and chambers to seize their occupants." In agreement with Wroughton, Escherich describes the habits of a ponerine ant, *Lobopelta ocellifera*, which he calls "die Termitenrauberin par excellence." A whole army of this ant may proceed in a file to a termitarium, break into its galleries and carry away the workers and larvæ in great numbers. An interesting new genus and species of ant, *Pædalgus escherichi* Forel was discovered nesting in the termitaria in small chambers which evidently communicated by means of very slender galleries with the galleries or chambers of the termites. From the great disparity between the size of the queen and that of the worker—the former measuring 5.5 mm., the later 1.1–1.2 mm.—it is inferred that this species must be a thief-ant like the species of *Carebara*, *Oligomyrmex*, *Aeromyrma* and *Solenopsis*, which are also known to live as thief-ants in termitaria or the nests of other ants.

Escherich discusses, in this connection, the habits of a few guests or termitophiles, espe-

cially the carabid beetle *Orthogonius acutangulus*, the swollen or "physogastric" larvæ of which feed on the termites Wasmann had supposed that these larvæ were adopted and fed by the termites in the place of their own huge queens, but Escherich shows that there is nothing to support this view The first chapter of the book concludes with an account of the growth of termitaria and the architectural instincts of the worker and soldier termites

The second chapter is devoted to the habits of the species of *Eutermes*, which have peculiar nasute soldiers, and especially to a charming account of *E monoceros* a black termite which goes forth in long processions fully exposed to the tropical sun to browse on the lichens on tree-trunks and the roofs and walls of houses These processions are indeed "erstaunlich," since they may be several hundred meters long and make the most unaccountable détours, "often three and four times the shortest distance to the feeding grounds" Escherich estimates the number of individuals in a colony of this species at about 200,000 It reminds one of a common European ant, *Lasius fuliginosus*, not only in its dark color and its tendency to form these long processions, but also in its nesting habits Its termitarium is a carton structure and, like that of *L fuliginosus*, situated in a hollow tree-trunk Escherich finds that it also forms on the outside of the trunk an "Abtritt," or latrine near its nest, a black stalactite-like mass which grows gradually as the workers add their feces to it and eventually drops from the tree or dissolves away in the tropical rains It is, however, constantly renewed and is guarded by a cordon of soldiers called by Escherich guards of the latrine ("Abtrittswachter") Since the workers and soldiers of *E monoceros* are blind, Escherich was naturally led to investigate their "homing" instincts Bugnion, who had previously studied this same termite in the same locality, showed that its sense of smell is very acute, and Escherich finds that the workers while they move along discharge from time to time small, black fecal masses which adhere firmly to the substratum like so many fly-specks and serve as guide-posts for the workers and soldiers that follow He concludes, therefore, that the "spoors of the black termites not only have a more intense odor than those laid down by the ants, but are much more stable and persistent" A brief account is added of the habits of some other species of *Eutermes* and especially of the "gallery" termite (*E ceylonicus*), which, like most species of the genus, constructs a gallery or arcade under cover of which it moves from place to place

The third chapter is full of interesting miscellaneous observations and accounts of laboratory experiments It opens with some remarkable notes on the queen termite and contains confirmation of Holmgren's recently published theory according to which the queen termite sweats out on to the surface of her body a substance ("exudate") which is eagerly devoured by the workers and not only keeps the helpless queen supplied with attendants, but, so to speak, binds the whole colony together Not only are the attendant workers continually licking the body of the queen, but Escherich actually saw a worker tear a strap-like piece out of its mother's hide and lap up the liquid exuding from the wound He noticed also that the unwieldy bodies of the queens are often scarred in such a manner as to suggest that this treatment is not unusual The exudate thus obtained by licking or even wounding the queen is often distributed to other workers by regurgitation From these and many other observations Escherich infers "that the eager licking of the queen has its origin not only in the cleansing instinct of the workers, but quite as much in their feeding instincts, or, as Holmgren says, in their 'exudate-hunger'" The queen termite is therefore fed and cherished by her offspring as if she were herself a termitophile, or termite guest, and for the same reasons, and since the other castes—i e, the males, workers and soldiers and their larvæ—also have exudate organs of peculiar structure, Holmgren assumes that the whole problem of caste differentiation in these insects is to be solved with the aid of the exudate theory In

other words, "the amount of exudate determines the amount of food and the latter determines the development of one or the other caste" It is certainly noteworthy, in this connection, that the queen termite, in the egg-laying stage, is clearly afflicted with physogastry, a condition which, as Wasmann has shown, is as characteristic of the guests of termites as the possession of trichodes is characteristic of myrmecophiles

In the same chapter Escherich gives an account of a number of experiments on the behavior of termites brought together from different colonies He found that alien larvæ are much less hostile to one another than are strange imagines (workers or soldiers) As would be expected, the soldiers of different species differ markedly in their methods of attacking and killing their enemies the *Termes* soldier uses its sharp mandibles as a poniard or pair of scissors, the *Capritermes* soldier as a catapult with which to toss its enemies into the air, the *Eutermes* soldier, however, pounds its enemies with its cephalic horn and simultaneously smears their bodies with a sticky secretion from its cephalic gland, the *Coptotermes* soldier reduces its enemy to impotence by throwing over it a milky secretion When termite colonies are invaded by small enemies, the workers often do all the fighting and the soldiers slink away, but larger and more powerful enemies are attacked by the soldiers while the workers behave rather indifferently The main function of the soldiers is to defend the nest entrances

Escherich is of the opinion that the negative phototaxis of termites has been greatly overestimated, but while this may be true of *T redemanni* and *obscuriceps* which were seen building, and of *E monoceros* which was seen foraging "am hellen Tage im grellsten Sonnenschein," the other observations cited do not prove the indifference of termites in general to light Ants, too, are in the main negatively phototactic, though they often forage and build in the bright sunlight

The fourth chapter is devoted to the methods of exterminating termites, a matter of great importance in tropical countries where these insects are often a serious menace to all wooden structures, books, papers, cloth and even to the stems of growing plants (tea, cacao, etc) The following measures are recommended first, stopping some of the main openings of the nest with tow or "waste" soaked with carbon bisulphide and closing all the remaining openings with clay or earth, second (and this is recommended as the most effective treatment), the use of the "universal ant-exterminator," an appliance manufactured by C Henwood & Son, of Durban This consists of a small charcoal stove connected on one side with a hand-pump (resembling that used for inflating bicycle tires) and on the other with a rubber hose provided with a nozzle On glowing charcoal in the bottom of the stove a small quantity of a powder consisting of 85 parts of arsenic and 15 parts of sulphur is placed, the nozzle of the hose is inserted in the entrance of the termitarium and the poisonous fumes which fill the stove are forced into its galleries and chambers by working the pump The hose is then removed, the openings are at once plugged with clay and the nest is left undisturbed for several days If at the end of a week's time some of the termites are found to have survived, the fumigation has to be repeated Escherich describes an interesting apparatus for locating termites, a "Termitensucher" manufactured by Friedrich Suck, of Hamburg, for use in the German colonies This consists of a microphone inserted in a funnel at the end of a steel tube and connected with a telephone receiver When the tube is stuck into the earth the noise made by the crawling termites can be distinctly heard through the receiver even when they are working at a considerable depth in the soil By means of this apparatus termites may be readily located in the tree-trunks of orchards or estates or in the walls of houses and marked for treatment with the arsenic-sulphur fumes

The work closes with the following series of valuable appendices by various authors on the material collected by Professor Escherich in Ceylon, a taxonomic account of the Ceylonese

termites by Holmgren, a similar account of the ants by Forel, descriptions of the termitophilous coleoptera by Wasmann, a description of a new cricket (*Myrmecophila escherichi*) which has become termitophilous, by Schimmer, termitophilous thysanura, myriopoda and coleopterous larvæ by Silvestri, a termitophilous earthworm (*Notoscolex termiticola*) by Michaelsen.

W. M. Wheeler

SCIENTIFIC JOURNALS AND ARTICLES

The contents of *The American Journal of Science* for April are as follows:

"Ionization of Different Gases by the Alpha Particles from Polonium and the Relative Amounts of Energy Required to Produce an Ion," T. S. Taylor.

"Heat Generated by Radio-active Substances," W. Duane.

"Contributions to the Geology of New Hampshire. IV. Geology of Tripyramid Mountain," L. V. Pirsson and Wm. North Rice.

"Note on a Method in Teaching Optical Mineralogy," F. W. McNair.

"New Paleozoic Insects from the Vicinity of Mazon Creek, Illinois," A. Handlirsch.

"Results of a Preliminary Study of the so-called Kenai Flora of Alaska," A. Hollick.

SPECIAL ARTICLES

THE ORIGIN OF FIVE MUTATIONS IN EYE COLOR IN DROSOPHILA AND THEIR MODES OF INHERITANCE

The White Eye

In cultures of *Drosophila ampelophila*, that had been closely inbred for a year, a male fly, lacking the red pigment of the eye, appeared. The same stock has continued to produce these white-eyed mutants always of the male sex. A white-eyed father transmits the character to about one fourth of his grandsons, but to none of his granddaughters. In this sense the character is sex limited. The white eye can be transmitted, however, to the females, most readily by breeding any white-eyed male to red hybrids (F_1) out of white by red. White-eyed males and females give pure stock. When a white-eyed female is bred to any wild male all of the female offspring have red eyes and all of the male offspring white eyes. The result shows that the male-bearing sperm of the wild flies lacks at least one of the factors essential for the production of red eyes. This statement does not mean that the male-determining sperm lacks all of the factors essential for producing red, but only that it lacks one of the factors necessary for the production of red. In fact, it is conceivable that all of the rest of the cell may be equally essential for the production of red, but in the absence of one condition (factor) the red fails to develop. It is in this sense that I understand the use of the word "factor" in inheritance, and in the same sense one might employ the word "unit character," although the latter word may seem to imply (from usage) that a particular character is represented entirely by some unit in the germ cells. We are not warranted, I believe, in extending to the results of Mendelian inheritance such an interpretation. Since I have discussed elsewhere the mode of transmission of the white eyes,[1] I shall omit further details here.

The Pink Eye

This eye color has appeared at least twice in cultures in no way closely related to the white-eyed stock. It is not due to a cross between red- and white-eyed flies. The color is much lighter and more translucent than red, and appears to contain more yellow. It is seen to best advantage soon after the flies have emerged. Later it becomes darker and casual observation might mistake it for red. As the flies get old the pink changes to a somewhat purplish color, and this change does not take place in the red eyes, so that with experience there is no difficulty in separating the two colors at all stages. No intermediate condition has been seen despite the fact that thousands of the pink-eyed flies have been examined.

Pink-eyed males bred to wild red-eyed females produce all reds in the first generation. These flies, inbred, have produced in the second filial generation 3,063 reds to 169

[1] Science, July 22, 1910.

pinks, males and females. The reciprocal cross, viz., pink-eyed females and red-eyed males, gives also in the first generation red-eyed individuals only. These inbred have produced 1,133 reds, males and females, and 237 pinks, males and females. The results show that pink is not sex limited. The simplest explanation of the difference between the modes of inheritance of pink and white eyes is found, I think, if we ascribe the factor involved in the formation of pink eyes to some other part of the mechanism than that involved in the formation of white eyes. If I am right in ascribing the sex-limited inheritance of white eyes to some change in one of the sex chromosomes, then the factor for pink eyes must be contained in some other part of the cell, possibly in some other chromosome. That this must be the correct interpretation is borne out by the results of the second cross just given, in which the male-producing sperm of the red-eyed male produces red eyed males. Evidently this sperm adds the necessary factor to the pink-bearing egg to produce red eyes, which would not be the case if the factor in question was present in the sex chromosome which is assumed to be absent from this spermatozoon. The hypothesis also makes clear how important it may be to recognize that different parts of the cell may be involved in producing such a "unit character" as eye color.

The relation of pink to white eyes is extremely interesting. When a pink-eyed female is bred to a white-eyed male all of the offspring have *red eyes*. These inbred produce red-, white- and pink-eyed offspring in the following proportions:

Red eyed females	418
Red eyed males	198
White eyed males	222
Pink eyed females	117
Pink eyed males	35

White eyes appear again in this combination as sex limited. The pink eyes are relatively few in number, and the *females* are about three times as numerous as the males.

The reciprocal cross, viz., white-eyed females and pink-eyed males, gives in the first generation *red-eyed females and white-eyed males*. These inbred produce

Red eyed females	411
Red eyed males	333
White eyed females	377
White eyed males	365
Pink eyed females	76
Pink eyed males	94

In this combination both males and females with white eyes appear in the second generation in about the same proportion as the red-eyed individuals. The pink eyes are again fewer than the other classes, but now the *females* are somewhat less numerous than the males. These peculiar results can, I believe, be accounted for theoretically, but the analysis is too elaborate to give here.

These results indicate that the white eye lacks one factor for red and pink eye, another factor for red. When combined all the elements for red are present. But the second generation shows that the reds formed in this way by recombination differ from the ordinary reds in that they produce reds, pinks and whites. The difference between these artificial reds and the normal reds consists in the presence of one dose of red in the artificial and two in the normal reds (at least in the female). The segregation is a consequence of this heterozygous condition. If this view is correct it should be possible to produce by the proper combinations some pinks and whites that when combined no longer produce reds, but only pinks and whites. I have made such races that have continued for several generations to produce pinks and whites only in very large numbers. In order to discover whether the induced change in this new race has taken place in the white or in the pink, the following experiment was carried out. One of the new pink females was crossed to a white male of the ordinary stock. This combination gave, it will be recalled, with ordinary pinks, red males and females, as stated above. The same thing occurred in the new experiment, showing that the pink had not been changed. On the other hand, when a white male of the new "pink-white" stock was crossed to an ordinary pink

female only pinks and whites were produced. Evidently the change has taken place in the white. If we express the ordinary red color as the outcome of two factors C and R then the *ordinary* whites will be OR while the *new* white will be represented by OO. The tests that I have made so far corroborate this view, giving the combinations expected from the formulæ. Theoretically the new white should behave towards the new pink as a sex-limited character in the same way in which the original white behaved towards the reds, and such, in fact, is the case. Moreover, it is clear why in the one case (white and pink) there should be sex-limited inheritance and in the other (red and pink) a different kind of inheritance, provided, as the facts strongly indicate, that the factor for pink is contained in another part of the hereditary mechanism than the factor for white. In other words, the factor for white (absence of red) is connected with the factor that determines sex, while that for pink is contained in a different part of the cell. It is this evidence that has seemed to me to show that the phenomenon of sex-limited inheritance is due to an intimate physical relation between the sex factors and the other factors in question, and the most obvious connection is that the relation is to be found in the chromosomes that carry both the sex factor and those factors that are sex limited.

The Bright Red Eye

This color arose in hybrids produced by breeding flies with miniature wings to wild stock. A small percentage of the male offspring had bright red eyes. This cross has been repeated a number of times and has always given some bright red-eyed flies. There can be little doubt that it is produced in some way by the cross. I found, it is true, one individual with bright red eyes in the wild stock from which the cross was made, but only once in many hundreds of flies examined, while the production of coral eyes is a constant feature of the hybrids.

The bright red eye is sex limited, as shown by the fact that in certain combinations it has appeared only in the males. When such males were bred to their red-eyed sisters, bright red-eyed females as well as males were produced. When two bright red-eyed individuals are mated they produce only bright red-eyed offspring, and I have a large stock of these flies that originated in this way.

The bright red eye differs from the red eye in being *conspicuously* more brilliant in color. No intermediate condition has been found. The relation between this color and red and pink has not yet been fully worked out.

The Orange Eye

A cross between a white-eyed male and a red-eyed female (heterozygous for pink) produced flies with red, bright red, pink, white eyes, and a few flies with eyes having a faint orange tinge. The eyes are much lighter than pink eyes, and do not seem to intergrade with them. The appearance of the orange color in this and in other cultures followed the appearance in them of the bright red eye, and seems to be connected with the factor for bright red. As yet this relation has not been clearly worked out. Orange bred to orange has given in some cultures stock that has produced many hundred flies with orange eyes only. The orange eye has not been found to be sex limited in any of the many combinations that have so far been made. Thus while white and bright red eye colors are sex limited the other two colors, pink and orange, do not show this form of inheritance. Now that pure cultures of all the stocks have been obtained, their interrelations will be further studied.

The Spotted Eye

On two or three occasions flies appeared in which some of the ommatidia of the compound eye were red and the rest white. The last individual of this kind that appeared was obviously a white fly with about one fourth of the area of one eye red, the rest white. The other eye was entirely white. Unfortunately the fly died before she could be tested. The occurrence of this mutation is of interest in its bearing on the origin of the spotted condition in many of our domesticated animals.

These cases are comparable to heterozygous flies with one long wing and one short,

proportionate—one the dominant the other the recessive type. Two such flies have been bred to the recessive form and have given long- or short-winged offspring—no fly with both types of wing. Inbreeding these longs to shorts again has not yet produced a single fly with both types of wings. Evidently the asymmetrical condition is due to a somatic change that takes place in the development of the individual, a change comparable to that that takes place in the germ cells of Mendelian hybrids. The same explanation applies to the case of the spotted eyes also. The spotted condition appears therefore to be an ontogenetic segregation.

T. H. MORGAN

COLUMBIA UNIVERSITY

HEREDITY IN INSANITY

THE fact that nervous and mental diseases are often transmitted by heredity was known to Hippocrates and has since his time been amply illustrated by insane-hospital statistics, but the exact conditions under which such transmission occurs have never been fully understood. A recent study has, however, revealed some data which seem to indicate that certain forms of insanity are transmitted from parent to offspring in the manner of a trait which is, in the Mendelian sense, recessive to normal.[1] The accompanying table shows the actual findings recorded in the study here referred to, these findings, it will be observed, are in fairly close correspondence with theoretical expectation, which is as follows:

1. Both parents being neuropathic, all children will be neuropathic.

2. One parent being normal, but with the neuropathic taint from one grandparent, and the other parent being neuropathic, half the children will be neuropathic and half will be normal but capable of transmitting the neuropathic make-up to their progeny.

3. One parent being normal and of pure normal ancestry and the other parent being neuropathic, all the children will be normal but capable of transmitting the neuropathic make-up to their progeny.

4. Both parents being normal but each with the neuropathic taint from one grandparent, one fourth of the children will be normal and not capable of transmitting the neuropathic make-up to their progeny, one half will be normal but capable of transmitting the neuropathic make-up, and the remaining one fourth will be neuropathic.

5. Both parents being normal, one of pure normal ancestry and the other with the neuropathic taint from one grandparent, all the children will be normal, half of them will be capable and half not capable of transmitting the neuropathic make-up to their progeny.

6. Both parents being normal and of pure normal ancestry, all the children will be normal and not capable of transmitting the neuropathic make-up to their progeny.

Types of Mating	Number of Matings	Total Offspring	Neuropathic Offspring	Normal Offspring: Neuropathic Progeny	Normal Offspring: Without Progeny	Normal Offspring: Normal Progeny	Died in Childhood	Data Unascertained
$RR \times RR \infty RR$	3	16	10	0	0	0	5	1
$DR \times RR \infty DR + RR$	19	129	45	14	20	27	20	3
$DD \times RR \infty DR$	5	18	0	8	2	7	1	0
$DR \times DR \infty DD + 2DR + RR$	7	54	12	6	18	10	8	0
$DD \times DR \infty DD + DR$	1	4	0	1	0	3	0	0
$DD \times DD \infty DD$	0	0	0	0	0	0	0	0

D = Dominant. R = Recessive.

RR = Neuropathic subject (nulliplex inheritance).

DD = Normal subject of pure normal ancestry (duplex inheritance).

DR = Normal subject with neuropathic taint from one parent (simplex inheritance).

[1] "Preliminary Report of a Study of Heredity in Insanity in the Light of the Mendelian Laws," by G. L. Cannon and A. J. Rosanoff. Read before the New York Neurological Society, October 4, 1910.

Results similar to those recorded in the table here given have been obtained in a much more extensive study of heredity in feeble-mindedness which was recently reported by Goddard.[3]

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THE TEXAS CALIFORNIA ARC OF PRIMARY TRIANGULATION

A GREAT arc of primary triangulation more than 1,200 miles in length, extending from central Texas to the Pacific coast, has just been completed by the Coast and Geodetic Survey. It connects the 98th meridian primary triangulation in the vicinity of Weatherford, Texas, with the Pacific coast primary triangulation in the vicinity of San Diego, California.

It is connected with the United States and Mexican Boundary at a number of places and is joined to and correlates a number of detached government surveys. It furnishes the geographic positions on the U. S. Standard Datum, of more than two hundred points which can be used to control all future public surveys within the region traversed.

There are 92 primary stations in the main scheme of this triangulation and, in addition, 38 stations in secondary schemes which provide for the connections with United States-Mexican boundary monuments and existing triangulation. The total area covered by the triangulation is 48,400 square miles, the average length of line east of El Paso is 17 miles, and from that place to the Pacific coast it is 62 miles. The maximum length of line is about 120 miles. The observations were made with a 12-inch theodolite, the pointings being made on heliotropes and acetylene lamps mounted at the stations observed upon. During the progress of the triangulation two primary bases were measured and 24 primary azimuths were observed.

The reconnaissance for this work was made between September, 1907, and February, 1908, and the observing was done in three seasons between November, 1908, and February, 1911. The total work was done in less than three years and six months, and the observations in less than two years and four months.

While the Coast and Geodetic Survey has, in the past, made more rapid progress on primary triangulation in the United States than that made in any other country, yet the rate of progress on the Texas-California arc exceeds that on any other arc in this country and the unit costs per square mile of area covered by the main scheme and per mile of progress are only about one half those of the triangulation between Marysville, Cal., and Tacoma, Wash., the arc for which, previously, these unit costs were the lowest. The accuracy, as measured by the closing errors of triangles of the Texas-California arc, is greater than that specified in the requirements for such work.

The remarkable rapidity of progress and the low cost of the work were largely due to the small amount of camp equipage used by each unit of the party, to the fact that only two officers had charge of field work, the writer on reconnaissance and a portion of the first season's observing, and Mr. J. S. Hill on the remainder of that season's work and that of the succeeding two seasons, and to the services of a most efficient signalman, Mr. J. S. Bilby, who was attached to each party from the beginning of the reconnaissance to the end of the observing. The parties were organized and managed, in the main, in a manner similar to that of the parties engaged on other pieces of primary triangulation done by this survey in recent years, only such changes being made as were necessary to meet new conditions which were encountered in semi-arid and arid sections, much of which was also mountainous.

This arc of primary triangulation will not necessarily be discussed separately by this survey in investigations of the figure of the earth, as were the two great arcs, one extending across the continent along the 39th parallel of latitude and the other paralleling the Atlantic coast from Maine to the Gulf, and known, respectively, as the "transcontinental arc" and

[3] *Amer. Breeders Magazine*, Vol. I., No. 3.

the "oblique arc" In the last two publications by the Coast and Geodetic Survey on investigations of the figure of the earth (entitled, "The Figure of the Earth and Isostasy from Measurements in the United States" and "A Supplementary Investigation in 1909 of the Figure of the Earth and Isostasy") the method was adopted of using the entire connected network of triangulation

WILLIAM BOWIE,
Inspector of Geodetic Work
COAST AND GEODETIC SURVEY

THE ITHACA MEETING OF THE SOCIETY OF AMERICAN BACTERIOLOGISTS, DECEMBER 28-30, 1910

Bacteriology in General Education (president's address) V A MOORE

This address is printed in full in SCIENCE, February 24, 1911 (Secretary)

A Bacteriological Museum and Bureau for the Exchange of Bacterial Cultures at the American Museum of Natural History, New York C E A WINSLOW

The Department of Public Health at the American Museum of Natural History has equipped a laboratory to serve as a central bureau for the preservation and distribution of bacterial cultures of both pathogenic and non pathogenic organisms, and particularly of types of new forms and varieties It is hoped that the laboratories of medical schools, colleges, boards of health, agricultural experiment stations, etc, and those engaged in biochemical work of all sorts, will furnish the museum with cultures at present in their possession, and the laboratory is now ready to receive and care for all such cultures It is desired to have the history of the organisms in as full detail as possible and the museum will be glad, where necessary, to pay for the expense of transferring cultures and transcribing records Types of new species and varieties are particularly desired at the present time and as they may be isolated in the future

The laboratory plans also to keep on file descriptions of bacterial species in print or arranged in the form of the standard card and will be grateful for copies of any such descriptions

Descriptions filed in the department will be carefully preserved and living cultures will be kept in good condition, so far as possible, and will be supplied to corresponding laboratories and schools and other institutions which may desire cultures The laboratory, of course, can not undertake to keep on hand difficultly cultivable organisms, such as can only be maintained for a few weeks after isolation from the body, neither can it at present supply virulent cultures of organisms which rapidly lose their virulence under laboratory conditions It should, however, be able to furnish cultures of organisms of all the ordinary types, which can be maintained under cultivation Pathogenic forms will only be sent to properly qualified persons

It is hoped, further, that the laboratory may offer opportunities for work in systematic bacteriology, and facilities will be offered to properly trained workers who may desire to conduct such work at the museum or to obtain cultures for carrying it on elsewhere

The Proposed Microbiological Central Station in Berlin OTTO RAHN

This paper consisted of a review of the efforts put forth in Germany to establish a central station for investigations and distribution of microbiological cultures It was in line with the preceding paper, but indicates that the German policies are more extensive and complete (Secretary)

The Fermenting Capacity of the Average Individual Cell (Bacterium lactis acidi) OTTO RAHN

It is possible to compute approximately the amount of metabolic products formed by one bacterial cell in one hour This unit is called "fermenting capacity" Object of this computation is the separation of the two vital factors of microbial activity, the growth and the fermentation At present, this separation can be accomplished only by a mathematical calculation The fermenting capacity of the average cell is approximately given by the equation

$$X = \frac{S \log b/a}{t(b-a)\log^2},$$

where S is the amount of products formed during the time t, a is the number of cells in the beginning, b the number after t hours The fermenting capacity of the average cell of *Bacterium lactis acidi* is about 0 000,000,001 to 0 000,000,004 mg of lactic acid per hour This amount is of the same order of magnitude as the weight of the cell

Old cultures of *Bacterium lactis acidi*, if transferred into fresh milk, ferment very slowly because the power of multiplication as well as the

fermenting capacity are greatly reduced, both in about the same ratio. Increase of temperature stimulates growth and fermenting capacity. The comparison of a milk culture and a lactose broth culture showed a higher rate of growth in milk, a higher fermenting capacity in broth. Oxygen reduced the total amount of acid produced and in the two strains under study, the fermenting capacity is more influenced than the growth. It was found that transferring in sugar free broth for 32 days in succession did not influence the fermenting capacity at all.

The frequent statement that in young cultures growth takes place without fermentation is not based on actual experiments. The amount of products formed by a small number of cells must necessarily be so insignificant that it can not possibly be detected by chemical analysis. From the time when a chemical proof is possible, the parallelism is evident. There is no indication of a discontinuity. This is proved, however, only for true products of fermentation. Toxins may be secondary products and follow other laws.

A Halophytic Diplococcus: T. D. BECKWITH.

During the summers of 1907 and 1910 the principal cause of the reddening during preparation for market of salted codfish and other gadoid fish appeared to be a diplococcus which could not be isolated by use of standard media. Special media were devised, the first being an infusion of ordinary salted and unpreserved shredded cod flesh (100 parts) with distilled or rain water (1,000 parts) with the addition of 2 per cent. agar agar. The second medium was made by using pickle from the butts diluted once with distilled or rain water and with 2 per cent. agar agar added. The NaCl content of these media averaged 5.25 per cent.

Upon these media at 30° C. in 96 hours salmon pink colonies appeared upon plating out pinkened fish flesh. The predominant colony form was a diplococcus. This coccus is 0.4–0.5 μ in diameter in freshly isolated cultures, later upon repeated transfer during two years' time, it showed swollen involutionary forms sometimes 1.0 μ in size. The adjacent sides of the units of the diplococcus are slightly flattened like the gonococcus. It stains easily with all common formulæ such as carbol-fuchsin and methylene blue. It is Gram positive, non motile, although having a very marked brownian motion. No capsule could be demonstrated, although the colony on immersion in water showed slight zoogloea-like characteristics. It is an obligatory aerobe. Colony is 1–2 mm. in diameter with edge slightly raised. In chromogenesis the colony is salmon pink but color is somewhat lessened after repeated transfer, becoming pinkish white. In pure culture feeble growth appears on standard neutral beef agar but is not fostered by the other common media in vogue.

No description could be found of this diplococcus and it is thought to be a new species. As it appears on the salt flesh of practically all members of that family, the name of *Diplococcus gadidarum* n. s. is proposed.

Later it was demonstrated that sometimes the form may be isolated on A. P. H. A. standard beef agar plus 7–10 per cent. NaCl. Such a method is not at all certain in result, however.

On account of the fact that fish acted upon by this form undergo rapid decomposition due to its effects, and its characteristics are so halophytic tests were made to compare its growth in a saline medium with two most common forms of albuminous disintegration, *B. subtilis* and *B. fluorescens liquefaciens*. The sets of media were prepared by the addition of various per cents. of NaCl to A. P. H. A. standard beef agar with neutral reaction. Plates were incubated 96 hours at 30° C. The following table shows the points of repression of growth of these microorganisms upon such media and demonstrates the strong halophytism of this diplococcus.

Per cent. of NaCl	0	1	2	3	4	5	6	7	10	12.5	15	20
Diplococcus gadidarum	+	+	+	+	+	+	+	+	+	+	+	0
Bacillus subtilis	+	+	+	+	+	0	0	0	0	0	0	0
Bacillus fluorescens liquefaciens	+	+	+	+	+	0	0	0	0	0	0	0

Optimum condition for *Diplococcus gadidarum* n. s. is indicated to be 5–10 NaCl, for *B. subtilis* and *B. fluorescens liquefaciens* 0–1 per cent.

At Gloucester and afterwards in our laboratories, repeated smear preparations made from particles of fish flesh taken from the most reddened portions along the vertebræ where the coloring is most prominent and generally makes its first appearance, showed this diplococcus to be the most prominent form. It seems likely then that this diplococcus is one of the most destructive

agencies in the reddening of prepared salted fish During the seasons of 1907 it was predominant on the samples examined, although it is possible to conceive that varying seasonal conditions of different summers may change the predominant form so that some other one of the various microorganisms as the causal factors of "red fish" may become the most destructive ones This question is worthy of further study

Bacterial Flora in Milk H W CONN

A general résumé of the present status of dairy bacteriology was furnished by this paper, and it also touched upon the significance of bacteriology in the control of municipal milk supplies (Secretary)

Relation of Form of Milk Pail to Germ Content of Milk H A HARDING and J K WILSON

The first important infection of milk occurs during the act of milking

Ordinary milk pails have open tops, 12 or more inches in diameter Many improved pails have been suggested, but few have been favorably received by dairymen

The leading causes for rejection are the excessive height of the pails and the inconvenient size and shape of the opening for receiving the milk

Tests of various pails indicated that a successful pail should not be over 12 inches high and should have an opening of approximately 25 square inches An oval or elliptical opening is more convenient than a round one of the same area

Stocking found that the use of cloths or mechanical strainers on pails was not desirable and that the relative efficiency of small topped pails was greater under poor dairy conditions

Under high grade dairy conditions when a good small-topped pail was contrasted with an ordinary 18 inch open pail the reduction in germ content was more than 50 per cent As such a pail is as convenient to use and practically as cheap as an ordinary pail, there seems to be no reason why it should not be generally adopted

The Influence of the Products of Lactic Organisms upon Bacillus typhosus Z NORTHRUP

This study was taken up first from the standpoint of the longevity of *B typhosus* in sour milk Previous investigations show that the typhoid bacteria in infected milk are generally all killed within twenty four hours after the milk has reached 0 4 per cent lactic acid

Several widely varying types of lactic organisms were obtained from various sources for this study, *B typhosus*, from the laboratory stock culture The typhoid bacteria and a lactic acid producer were grown together in sterile milk after the milk had soured, the combined culture was plated at intervals A special plating medium was used in two succeeding tests for differentiating the typhoid and lactic organisms, one lactic only was inhibited by the bile agar used as a differentiating medium

Assuming that it is the products of the lactic bacteria and not the bacteria themselves which exert the inhibitive influence upon the typhoid bacteria, the plan was formulated of growing the typhoid bacilli in their products alone The lactics were grown in lactose broth, allowed to produce an amount of acid, then filtered through a Chamberland "F" bougie As a result of these experiments, it was found that a certain amount of the acid produced by the typical lactic organisms has greater germicidal properties than the same amount produced by any other type of lactic organism The typical lactic kills *B typhosus* at + 37° acid or 0 3 per cent lactic acid while the acid made by *B bulgaricus* and another strong acid producer reaches nearly twice 0 3 per cent lactic acid in the lactose broth before the typhoid organisms are killed

A comparison was made establishing the relative amount of acid produced in lactose broth and milk by lactic organisms According to these results, + 37° acid, the minimum inhibitive acidity, produced by No 2 in lactose broth, corresponds to + 80° acid or 0 72 per cent acid in milk

Summarizing, if strong lactic organisms are present in large numbers in infected milk, it may be definitely stated that all typhoid bacteria will be killed when the acidity in the milk reaches 0 72 per cent lactic acid

The Use of Fermentation Tests in the Study of the Lactic Bacteria L A ROGERS

It was found that the characters used in describing the lactic bacteria are not distinctive or are too variable to separate this group into sub groups

The curdling of milk is especially variable and uncertain

The fermentation of various test substances was found to be constant and, when properly correlated, to indicate natural grouping

By means of these tests it was possible to separate the 150 cultures studied into three groups Each of these groups was distinguished by fermenting or failing to ferment certain groups of test substances

The Normal Number of Body Cells in Cow's Milk R S BREED and I READ STEDGER

A report on some determinations made at Allegheny College and the University of Gottingen by the use of the direct method of counting these cells devised by Prescott and Breed[1] A series of examinations was made of cream and skim milks obtained in a variety of ways to determine what became of these cells when the milk was separated or centrifuged The results obtained were so variable that the final conclusion was that none of the methods using the centrifuge can be made satisfactory enough to give results of any value so far as determining the number of cells present is concerned A necessary corollary of this conclusion is that all the deductions based on the use of these methods, careful and painstaking as much of this work has been, are worth less so far as they are based on the numerical factor alone A daily examination of the milk of three normal cows extending over a period of six weeks indicates that there may be a cyclic variation in the number of these cells and showed variations in numbers ranging from 0 to 20,000,000 and more in milk which was apparently normal in every particular

What is the Value of Quantitative Bacteriological Determinations in the Control of City Milk Supply H A HARDING

Their educational value is slight because dairymen are unable to translate quantitative results into terms of dairy processes and laboratory workers are also unable to do this until they have located the particular difficulty by other means

As legal standards quantitative results have little value because they fluctuate so widely, dependent upon the technique used A variation of 100 per cent is frequently observed between the results of two equally accepted methods of determination

They are not necessary, since the best results in improvement of city milk supply can be obtained without the aid of quantitative determinations

They are useful as a check upon the work of dairy inspectors and in determining which dairies are most in need of close observation Where the force of inspectors is not adequate to a close supervision of all the dairies, bacteriological determinations will indicate where the inspector's energy can be most wisely employed

Their greatest value is in measuring the sources of infection There is at present a lack of much data and thousands of dollars are being wasted in present attempts at producing sanitary milk because the relative importance of various avenues of infection are not understood

Apparatus for Collection of Deep water Samples PAYN B PARSONS

Description of a sampling apparatus for use in collecting samples of water for bacteriological examination, where the depth of water is very great and the currents are strong

A single rope used for lowering and raising the lead pipe container and for breaking off the neck of the vacuum tube or releasing the stopper

Also a description of an apparatus for the collection of chemical samples and one especially adapted for dissolved oxygen samples, where the samples must be taken in very deep water and the line kept plumb in the currents

Bacteria in the Waters of New York Harbor PAYN B PARSONS

Table giving the average number of bacteria in the water of New York harbor at the surface and at the bottom during 1909

Table giving the average number of bacteria in the water of New York harbor during ebb and flood tides during 1909

Averages of 1,082 examinations of water, made for the Metropolitan Sewerage Commission of New York, are included in the tables

Discussion of present dangers to the health of the people from the vast quantity of sewage dumped into New York harbor, with special reference to bathing and the oyster industry

Intensity of Pollution as shown by Numbers of Bacteria PAYN B PARSONS

A consideration of numbers of bacteria in various sections of New York harbor, including a comparison of the numbers occurring in samples collected in the Atlantic Ocean and in those taken at points where there was a high degree of pollution

Summary of the average number of bacteria in each distinct section of the harbor, during ebb and flood tides

Table showing average numbers of bacteria as compared with the average per cent of saturation with oxygen in the water of the various sections of New York harbor for all depths and tides during 1909 Eight hundred oxygen and 1,082 bacterial analyses, made for the Metropolitan Sewerage Commission of New York, are included in the averages

[1] See *Journal of Infectious Diseases* for 1910

Comparison of numbers of bacteria in mud deposits on the harbor bottom in samples collected from polluted and unpolluted sections.

Relation of channels and shoals to bottom deposits and bearing of this upon the oyster industry.

Biochemical Factors in Soil: M. X. SULLIVAN.

The soil is not an inert reservoir for plant food, but is the seat of physical, chemical and vital actions, the biochemical factors being especially prominent. Numerous bodies which occur in soils and arise either in the metabolic activities of microorganisms or are left in the soil after the decomposition of the plant and animal débris and perhaps occur also as a result of excretion from roots or from cell sloughing, play a considerable rôle in soil fertility. Some of these substances are harmful to plants, some beneficial. Fertilizers do work in soil in modifying the physiological functions of the microorganisms by bringing about suitable conditions for their development, in stimulating or retarding their digestion of inert bodies, and in furthering their enzymotic functions. Soils *per se* have oxidizing and catalyzing properties, while poor soils have these functions in a much lessened degree. Oxidation in subsoils which are of much poorer productivity than the surface soil is usually very slight.

Bacteria of Frozen Soil: H. J. CONN.

Results of work at Ithaca, N. Y., during 1909–10, showing a phenomenal increase in soil bacteria during the winter. Quantitative results already published.[2] Qualitative work includes the study of about 300 cultures.

Quantitative Results.—Increase from 7 millions per gram in November, 1909, to 33 millions in February, 1910, and from 8 in November, 1910, to 22 in December, 1910. These results are new, but are not disproved by previous work.

Possible Explanation.—There seem to be two different groups of organisms, one increasing in warm, the other in cold weather, the former requires so much organic food that a rapid increase is impossible.

Evidence in Support of this Explanation.—

Relation to Moisture Content.—Germ content and moisture content are usually parallel, the exceptions to this rule are such as to suggest an alternation in predominating types.

Relative Numbers of Rapid Liquefiers, Actinomycetes and Slow Growers.—The last group increases in winter.

Qualitative Results.—There are certain organisms present throughout the year. The others appear only at times and show a tendency to reappear at the same season another year. Fall and winter show the greatest diversity of types.

Classification of the types studied in this work.

1. Higher filamentous bacteria. Actinomyces.
2. Rapid liquefiers, producing spores. Mostly of the *B. subtilis* group.
3. Rapid liquefiers, without spores. All but one *Pseudomonas* forms.
4. Slow growers—without spores, producing punctiform colonies, partly show liquefiers, partly non liquefiers.

Medium used in quantitative work: Gelatin, 12 per cent., dextrose, 0.1 per cent., soil extract, 20 per cent. Reaction adjusted with NaOH to 0.5 per cent. acid to phenolphthalein. Soil extract for this medium prepared by boiling 30 minutes with an equal weight of water, then filtering.

Incubation period in quantitative work: 7 days. Temperature of incubation: 19°.

Viability of P. radicicola on Ash maltose agar: S. F. EDWARDS.

During the summer and autumn of 1906, cultures of *P. radicicola* were isolated from the nodules of nineteen hosts, on ash maltose agar. Colonies were transferred to the same medium in Freudenreich flasks which were kept in a darkened cupboard at laboratory room temperature. During the autumn of 1910, plates were made from these old cultures with the result that in fifteen of them the organism was still living. The results are shown in the following table.

In every case in which growth occurred, the colonies were typical, and stained preparations and hanging drops showed the typical characters of *P. radicicola*.

Pot tests in sterile sand were started, using seeds of alfalfa, red clover, peas and beans. At the time of writing, only the peas were sufficiently developed to examine. Of six control plants, not inoculated, three showed no nodules, and three showed 1, 10 and 12 nodules, respectively. Six plants inoculated with the 1906 culture showed 18, 33, 20, 25, 64 and 25 nodules, respectively. Stains from the nodules showed rod and branched forms typical of *P. radicicola*, and plates showed abundant growth in five days on ash maltose agar at room temperature. The work thus far shows evidence that *P. radicicola* retains its virility as well as its vitality after considerable periods of time in stock cultures under laboratory conditions.

[2] *Centbl. f. Bakt.*, II. Ab., 28, pp. 422–434.

Viability of P radicicola on Ash maltose agar

Host Plant	Alive after		
	Years	Months	Days
Siberian pea tree (*Caragana frutescens*)	4	4	4
Red clover (*Trifolium pratense*)	4	5	0
Soy bean (*Glycine hispida*)	No colonies on ash-maltose-agar		
Sweet pea (*Lathyrus odoratus*)	4	0	10
Garden pea (*Pisum sativum*)	4	2	17
Alsike clover (*Trifolium hybridum*)	4	3	21
Bitter vetch (*Lathyrus sativus*)	4	4	16
Flat pea (*Lathyrus sylvestris*)	No colonies on ash-maltose-agar		
Red clover (*Trifolium pratense*), isolated from dried plants sent from Medicine Hat, Alta	3	10	16
Alfalfa (*Medicago sativa*)	4	2	9
Black medick (*Medicago lupulina*)	4	4	16
Horse bean (*Vicia faba*)	4	0	29
Black locust (*Robinia pseudo-cacia*)	No colonies on ash-maltose-agar		
Honey locust (*Robinia viscosa*), medium dried to 7 mm from 28 mm	4	4	12
Dutch white clover (*Trifolium repens*)	4	3	20
Garden bean (*Phaseolus vulgaris*)	4	1	0
Scarlet runner bean (*Phaseolus multiflorus*)	No colonies on ash-maltose-agar		
Hairy vetch (*Vicia villosa*), medium dried to 4 mm from 24 mm	3	11	22
Sweet white clover (*Melilotus alba*), medium dried to 4 mm from 24 mm	4	4	14

Studies of Media for the Quantitative Estimation of Bacteria in Water, Sewage, etc STEPHEN DEM GAGE

The Variation in Composition of Beef Infusion —In a former report, the writer called attention to the fact that the variation in the amount of solids in beef infusion made by the standard procedure was as great as or greater than the amount of pepton added in the process of making gelatin or agar media from that infusion At that time (1904) it was suggested that this error might be considerably reduced if the beef infusion were made up to a constant specific gravity The records at the Lawrence Experiment Station show that while the specific gravity of coagulated and filtered beef infusion prepared according to the standard procedure, may vary between 1 100 and 1 005, about one half of the samples have a specific gravity of about 1 006, and this value was selected as a standard Analyses of a large number of samples of beef infusion adjusted to a standard specific gravity of 1 006 show that the range of variation in the total nitrogen and in the total organic and mineral matters in solution has been fully as great as when no correction of the specific gravity was attempted The error in reading specific gravity with a hydrometer may be as much as ten per cent A careful analysis of the records shows that the proportion of samples in which the total solids did not vary more than 10 per cent from the mean was increased from about 55 per cent in the case of samples of the usual beef infusion to over 75 per cent in the samples of infusion with a constant specific gravity, and a similar increase in uniformity is found in the total organic matters and in the total nitrogen In other words, the use of beef infusion of a constant specific gravity is a step toward media of more uniform composition, and toward increased accuracy in bacterial counts

The Influence of Quartz Sand upon Microbial Cultures OTTO RAHN

The object of this paper is to study the influence of soils upon microorganisms The decomposition of liquid media (milk, peptone solution) was compared with that of the same liquid absorbed in quartz sand, and great differences were found Naturally, aerobic processes were greatly increased and anaerobic processes greatly decreased when the liquid was mixed with sand in such proportion as to allow of abundant aeration Both aerobic and anaerobic processes were favored, however, when just enough liquid was added to the sand to keep it entirely submerged This indicates a peculiar influence of the quartz sand upon microbial action which is paralleled by the retardation or inhibition of poisonous effects upon plant roots by mere addition of quartz sand Surface attraction of the microbial products by quartz sand does not account for this phenomenon

Studies in Disinfection of Alfalfa Seeds J K WILSON

Sterile seeds are desirable if not necessary for the study of the relation of bacteria to plant life

Sterile legume seeds may be obtained from ripening pods, but occasionally they are needed when such a supply is not at hand

The utility of alcohol, corrosive sublimate and formaldehyde in providing such a supply has been tested on alfalfa seeds

Sterility of seeds so treated was tested by incubating them in standard bouillon and examining them macro- and microscopically

Seeds immersed in 70 per cent alcohol for 105

minutes were not sterile The effect of this treatment on germination was not tested

Immersion in $HgCl_2$ 1–1,000, for 2 minutes and washing eleven times in sterile water did not result in sterility This treatment did not reduce the percentage of germination of the seeds

Seeds immersed in 10 per cent formaldehyde for 80 minutes were sterilized only in a few instances The germination was reduced 3 per cent

Seeds were first put into 95 per cent alcohol for 10 minutes and then into 10 per cent formaldehyde for periods ranging from 15 minutes to 6 hours Only those treated 6 hours in formaldehyde were sterile The germination of the seeds treated 6 hours was reduced 65 per cent Ten minutes in alcohol did not reduce the percentage of germination

Seeds were first put into water in a vacuum chamber and the pressure reduced to 3 mm for 210 minutes A portion of these seeds, after being placed for 30 minutes in 10 per cent formaldehyde, was sterile, but the seeds did not germinate The vacuum treatment alone did not reduce the percentage of germination

Apparently the air in seeds prevents the entrance of disinfecting solutions and protects the bacteria

Method of Keeping Bacteria from Growing Plants J K Wilson and H A Harding

The main avenue of infection for experimental plants is through the air

Of the many ways which have been suggested for preventing this infection none of them are simple and effective

Harrison and Barlow have published on a method for growing legumes on agar in Erlenmeyer flasks This method can be improved by growing plants in sterile Mason jars, using sterile seeds and earth Exchange of gases is provided for by soldering a ½ inch tube into the metal jar top, plugging the tube with cotton and covering it with an inverted test tube to reduce the chances of contamination and to check evaporation

Alfalfa planted in such jars, in sterile sandy soil to which 10 per cent of water has been added, grew thriftily during four months without being watered or the jars being opened

(The jars exhibited contain alfalfa planted August 13, 1910, and the jars have not been opened since that date)

Bactericidal Properties and Variations in the Agglutinin Content of Antimeningococcic Sera Lawrence T Clark

Serum obtained from the horse which has received subcutaneous injections of first modified and later unmodified polyvalent suspensions of the meningococcus, acquires measurable quantities of agglutinin Intraperitoneal injections of similar suspensions, either mono or polyvalent, produce in the ram a serum of markedly greater agglutinating power

Homologous sera produced from six cultures respectively, by intraperitoneal injections in the ram, gave distinctly specific agglutinative reactions with but one exception—sera 4 and 6 and cultures IV and VI being interchangeable with similar results

Polyvalent antimeningococcic ram serum possesses decided bactericidal activity, as demonstrated by its effect in combination with complement on fresh living suspensions of the meningococcus

Studies on Immunity in White Rats and Mice against Spirochæta duttoni D H Bergey

White rats and mice that have recovered from a well marked infection with *Spirochæta duttoni* have a high degree of acquired immunity against the organism The serum of such immune rats and mice serves to protect normal animals against the infection

The degree of immunity developed is not always absolute, though it is always sufficient to induce a pronounced alteration in the severity and course of the infection If infection occurs, the onset is delayed, the number of organisms in the blood is relatively small, relapses are infrequent, and a fatal termination of the disease is prevented

The protective substances in the blood of the immune animals consist of at least three types of antibody Agglutinins are present early in the disease Bacteriolytic substances are developed as shown by the degenerative changes in the organisms toward the close of the disease Besides these tropic substances are undoubtedly of far greater importance in bringing about the very rapid diminution in the number of organisms in the blood

The final elimination of the organisms from the blood of the infected animals rests upon their englobement by the free and fixed cells of the body through the influence of the tropic substances

Agglutination of B choleræ suis during the Production of the Dorset Niles Serum Ward Giltner

Purpose—An effort has been made to throw some light upon the relation between *B choleræ suis* and hog cholera There has also been considered the possibility of a constant relationship between potency of serum and agglutinative power for *B choleræ suis*

Methods—The macroscopic, test tube method has been followed Cultures were isolated from the spleen of virus hogs At first a bacterial suspension was prepared by washing off surface growth from agar slants with carbol salt solution, later bouillon cultures were diluted with a solution of formaldehyde Blood samples were taken from the tail bleedings or at slaughter or death of pigs Samples of "mixed sera" were preserved in 5 per cent phenol generally

Results—Normal blood serum gave a maximum reaction at a dilution of 1–250 or less

Blood of virus pigs gave a maximum reaction at a dilution of 1–800, but usually less

Blood of pigs treated by the serum simultaneous method gave a maximum reaction at a dilution of 1–500 These pigs were younger than the virus pigs and, other things being equal, young pigs generally possess a blood of less agglutinative power than old pigs

The agglutination reaction appears to be a reaction of immunity since, as a rule, pigs treated by the serum simultaneous method possess a blood of higher agglutinative power if they live (develop immunity) than if they die (fail to develop immunity)

During the process of hyperimmunization agglutinins for *B choleræ suis* increase as the virus injections increase, but not necessarily simultaneously or in the same degree

Of 51 samples of Dorset Niles serum, only 11 gave an agglutination reaction at a maximum of 1–1,000 or less, while 7 agglutinated at 1–50,000

The agglutinative power of a mixed serum may decrease more or less than 50 per cent after 6 to 8 months in cold storage.

Potency of serum can not be measured by agglutinative power in all cases

Sera of high agglutinative power, *i e*, agglutinating at 1–2,000 or above, were potent in 85 71 per cent of cases and not potent in 14 28 per cent, sera of low agglutinative power, *i e*, agglutinating at 1–1,000 or less, were potent in 45.45 per cent of cases and not potent in 54 54 per cent

***Studies on the Filterable Virus of Hog Cholera*:** Chas T McClintock, Walter E King and Robt H Wilson (From the Research Laboratories of Parke, Davis and Co, Detroit, Mich.)

Results of experiments indicate that a relatively short residence of hog cholera serum in the circulatory system of the horse, in some way causes an activation of the virus Horse serum, obtained one half to one hour after the animal has received approximately 140 c c of hog cholera virus, is capable of producing more uniform results when injected into healthy hogs than corresponding dilutions of hog cholera serum in normal horse blood, *in vitro*, and in physiological salt solution The incubation period following the injection of horse serum virus is relatively short

The minimum fatal dose of virulent serum, as represented by a dilution of the virus in physiological salt solution, does not appear to indicate the minimum fatal dose where the dilution is maintained in the form of horse serum virus

From some analogous phenomena relative to the behavior of toxins, it is suggested that the filterable virus of hog cholera may contain a distinct toxin portion

A Discussion of the Preparation and Distribution of Biologic Products: J J Kinyoun

Founded upon the experiences of the author who has been intimately connected with the development in the production of biologic products in the United States, certain inductions of wide application were drawn pointing toward municipal and governmental manufacture and control (Secretary)

Intestinal Bacteriology A Résumé: Arthur I. Kendall

By feeding experimental animals (cats and monkeys) alternately with protein and carbohydrate, respectively, it is possible to demonstrate definite alternations in the intestinal flora both by staining and by cultural methods

These bacterial alternations consist essentially of a definite sequence of proteolytic and fermentative types of organisms In addition to these changes in the type of the intestinal flora as the diet of the host is alternated, certain bacteria are able to accommodate their metabolism to a protein and a carbohydrate regimen, respectively For example, *B. coli* possesses the power of accommodating its metabolism both to a protein and to a carbohydrate diet

This accommodation of metabolism to dietary changes is a fundamental and extremely important property possessed by many bacteria, and it can be utilized therapeutically

In lactic acid therapy it plays a prominent rôle feeding carbohydrate and cutting down protein in patients suffering from the absorption of protein putrefaction products leads to a change in the metabolism in many of the prominent bacteria concerned in the morbid process These organisms attack the sugar in preference to protein, since it has been shown by the writer that fermentation takes precedence over putrefaction in these bacteria

In exogenous infections, such as bacillary dysentery, it also is an important feature, since it is possible to influence favorably the associated bacterial flora by feeding lactose in these cases The lactose is hydrolyzed, and used by the dysentery bacilli and other organisms in the lumen of the alimentary canal Under these conditions the dysentery flora becomes fermentative instead of putrefactive, that is to say, the flora (dysentery bacilli, *B coli* and the streptococcus principally) form acid products instead of toxin and proteolytic products

Some Quantitative Methods of Examining Fecal Bacteria W J MACNEAL

This paper is a summary of the methods employed in studying the fecal bacteria of healthy men already published in *The Journal of Infectious Diseases*, 1909, together with certain additions to the technic made since The essential character in which the procedure is somewhat unique is in the plan of making every one of a large number of experimental results referable to a definite quantity of the mixed fecal flora, so that all the details of the comprehensive examination are quantitatively comparable with each other, and the results of one examination quantitatively comparable in detail with the results of another examination The experimental observations fall under two heads (1) the direct examination including (*a*) gravimetric determination of bacterial substance, (*b*) microscopic count of the bacterial cells by two methods and (*c*) differential count of Gram stained fecal flora, (2) the culture tests including five different sets of plate cultures and one set of separation tube cultures of the mixed fecal flora, three different sets of plate cultures of the fecal spores and a variety of fermentation tube cultures devised not only to show differences in the fermentative activity of the mixed fecal flora, but also and more especially to bring to development and aid in the eventual isolation of various fecal bacteria which may not be found upon the plate cultures For some of the results obtained by these methods those interested are referred to the papers cited above

Tests of the Virulence of Diphtheria Bacilli B L ARMS, M D, and E MARION WADE, B A

The paper gives the technic of the isolation and test and shows

1 The marked variation in the virulence of different strains of diphtheria bacilli isolated from the same culture, showing the necessity of testing several strains before releasing a case on a negative virulence

2 That as a rule if a case is proved positive by the virulence test the organisms retain their virulence as long as they persist, even though the case has completely recovered clinically

3 That where there is an outbreak of diphtheria the "carriers" often harbor organisms, even though no symptoms are present in the host

4 That sometimes the virulence may become enhanced, although this is the exception and seems to be more frequently true of institutional cases

Further Studies on Blackhead in Turkeys PHILIP B HADLEY

This paper presents some of the results of work on the blackhead disease of turkeys conducted at the Rhode Island Agricultural Experiment Station since July 1, 1908 The further investigations indicate that blackhead can not be considered as a specific disease, but that it includes several distinct etiological factors One of these, as first reported, is coccidiosis Another is now found to be infected with a species of flagellated organism These two factors (and perhaps others) may work either together or separately to produce the pathological appearances characteristic of blackhead Multiplication of the flagellates by means of spore formation has been observed in the tissues of the ceca and liver At an early stage of development many of the parasites lose their flagella and become ameboid In the motile stage the flagellates are characterized by the presence of two flagella, a membrane and a short "Achenstab" The length of the motile forms does not exceed 12 μ Encysted forms 12 μ–16 μ were observed A more detailed report of the investigation appears in the *Centralblatt fur Bakteriologie.*

Bacillary White Diarrhea of Young Chicks LEO F RETTGER.

The epidemic type of diarrhea which is characterized in part by a whitish diarrheal discharge, and which is now known as "bacillary white diarrhea," is caused by a bacillus which belongs to the coli typhi group of bacteria It has many

points in common with the typhoid bacillus. It may be cultivated easily on the ordinary laboratory media, but its growth on slant or plate agar is delicate, and very much like that of the *Streptococcus pyogenes*. This peculiar appearance on agar is a great aid in the identification of the bacillus, and hence in the diagnosis of the disease.

This organism, which has been named *Bacterium pullorum*, is present in the intestine, liver, lung, spleen, kidney, heart and unabsorbed yolk of chicks suffering with the disease in question. It is to be obtained most easily from the liver and yolk, when the latter is present.

Feeding experiments conducted on a large scale demonstrated that the disease may be transmitted to young chickens under three days old through infected food and drinking water. Furthermore, chicks may be infected with *Bacterium pullorum* before hatching. These two facts furnish an easy explanation as to the rapid spread of the infection among chicks many of which were normal at the time of hatching.

The mother hen is the source of infection in the egg. The examination of hens from which it was almost impossible to raise chicks, on account of white diarrhea, revealed the fact that the ovaries were infected with *Bacterium pullorum*. The diseased ova were very abnormal. They were discolored, misshapen and of all degrees of consistency. Eggs from those hens had been found to contain the specific bacillus in question in all stages of incubation. Later, a method was devised for identifying the bacillus in fresh eggs which came from infected flocks. Numerous eggs were tested, and the organism was observed in many of them. Thus, a satisfactory method is at hand for determining, without injury to the birds, which hens are infected with *Bacterium pullorum*, and consequently are the source of infection, if their eggs are used for hatching purposes.

Quite recently a pullet which was less than eight months old, and which was one of the survivers of an infected flock, showed the presence of the specific bacillus in the ovary. This discovery completed the cycle of infection. The laying hen is a bacillus carrier. Her eggs harbor the bacillus, and the chicks which are hatched emerge with the organism planted within them. These chicks are the source of infection of other chicks which are normal at the time of hatching. The disease becomes epidemic. The female chicks which survive carry the infection in their body until they are mature laying hens, and the same cycle is begun again, unless intelligent steps are taken to eradicate the infection by methods which are most apparent.

Carbolic Acid in Fowl Cholera: PHILIP B. HADLEY.

The prevalence of fowl cholera in many of the New England states is increasing. An attempt is being made at the Rhode Island Agricultural Experiment Station to devise methods for its prevention or control. Preliminary experiments have involved a study of the effects of subcutaneous inoculations of a 5 per cent. solution of carbolic acid upon fowls previously infected with the organism of fowl cholera, *Bacillus bipolaris septicus*. The results of this work to date have shown that repeated daily subcutaneous inoculations with 5 per cent. carbolic acid, in 3 c.c. amounts, have power to prevent the development of the disease in fowls infected from one to twenty-four hours previously with the cholera organism. The results were approximately the same whether the infections resulted from subcutaneous inoculation of the virus or from the ingestion of virulent material (feeding by glass pipettes). The possible manner of action of the carbolic acid was discussed. A more detailed report of this work appears in Rhode Island Agricultural Experiment Station Bulletin, No. 144.

The Etiology of Contagious Abortion of Cows: W. J. MACNEAL.

The existence of a contagious form of abortion in cattle has been recognized for a long time by practical husbandmen. Nocard (1886) made the first extensive bacteriological investigation of the disease, but failed to identify any microorganism as the cause. Bang (1896) found a small bacillus in the uterine exudate of aborting cows, grew it in pure culture, and produced abortion by injecting these cultures into cows and sheep. The peculiar oxygen requirement of the microorganism for growth in artificial culture was discovered and fully studied by Bang and Stribolt. Subsequently, the same organism has been isolated from cases of contagious abortion of cattle by Preisz (1902) in Budapest, Nowak (1908) in Krakau, McFadyean and Stockman (1909) in England, MacNeal and Kerr (1910) in Illinois, U. S. A., and by Zwick (1910) in Germany.

The microorganism is a very small rod, not motile and without spores. It is Gram-negative. Plate cultures are best obtained by streak inoculation on solidified serum agar, the plates being incubated at 37° in a closed jar from which the oxygen is partly exhausted. This is conveniently accomplished by putting plates of *B. subtilis* in

the jar along with the cultures of the abortion bacillus. The appearance of the colonies is characteristic, and coupled with the behavior toward oxygen is almost sufficient for identification. Subcutaneous injection of active cultures into pregnant guinea pigs causes abortion with great regularity.

Of the various names employed to designate the organism, *Bacillus* (or *Bacterium*) *abortus* Bang, is considered as the correct and appropriate one.

A Method for Determining the Germicidal Value and Penetrating Power of Liquid Disinfectants: ARTHUR I. KENDALL and MARTIN R. EDWARDS.

The method consists essentially of infecting plain agar with 24 hour cultures of *B. coli*, hardening the agar in sterile tubes of 1.5 cm. inside diameter and about 1 meter long, then cutting cylinders from the hardened agar by running it out slowly and sectioning it transversely into cylinders of about 2 cm. long with a sterile knife. The cylinders so obtained are dropped directly into the disinfecting solutions which it is desired to examine, and into 5 per cent. carbolic acid as a standard for comparison. Cylinders from each solution of disinfectant are removed at the end of stated intervals, washed in distilled, sterile water, and then a core removed from the center of each cylinder along the long axis by means of sterile quill tubing (3 mm. in diameter).

These cores so removed are placed in lactose fermentation tubes and incubated at body temperature for several days, making daily examinations for gas formation.

By comparing the results obtained with the various disinfectants with those of the standard carbolic acid, it is possible to formulate a coefficient which expresses the combined germicidal and penetrating power of the disinfectant in question with that of carbolic acid.

All abstracts have been supplied by authors unless otherwise stated.

CHARLES E. MARSHALL,
Secretary

EAST LANSING, MICH.

SOCIETIES AND ACADEMIES

THE PHILOSOPHICAL SOCIETY OF WASHINGTON

THE 690th meeting was held on February 25, 1911, President Day in the chair. Two papers were read:

Some Causes of Variations in the Polarization of Sky Light: Dr. H. H. KIMBALL, of the U. S. Weather Bureau.

The first part of this paper contained a brief résumé of the main features of sky polarization, together with references to some of the theories that have been advanced to account for them. Observations by different investigators were cited to illustrate the character of periodic variations in sky polarization, and a summary was given of observations by the author. These latter include measurements of the percentage of polarization at the point of maximum, *i. e.*, 90 degrees from the sun and in its vertical, as well as observations on the position of the neutral points of Arago and Babinet. They show (1) variations in sky polarization with place, apparently due principally to differences in the intensity of reflection from the surface of the earth, and (2) variations with meteorological conditions.

No connection is apparent between sky polarization and the pressure exerted by the aqueous vapor contained in the atmosphere. Dustiness, or any form of mechanical haze, decreases the percentage of polarization, but by far the most potent cause of such a decrease appears to be optical haze or the diffusion of light by reflection from the boundary surfaces of non-homogeneous layers or currents of air.

All of the observations included in the above summary were obtained when the sky was practically cloudless. Of the ten days on which the lowest percentage of polarization was observed seven were followed by rain before midnight of the succeeding day.

The Nature of the Sun: Dr. C. G. ABBOT, of the Smithsonian Institution.

In the preparation of a forthcoming book on the sun the speaker had attempted to explain solar phenomena on the hypothesis that the sun is completely gaseous, and not possessing the shell of clouds generally assumed to constitute the photosphere. The temperature of the sun seems to be of the order of 6500° absolute centigrade, and the pressure in the iron reversing layer about five atmospheres. In these circumstances it seems highly improbable that matter other than gaseous exists. A continuous spectrum was held by the speaker to be the natural consequence of the immense thickness and considerable pressure of the radiating gas sphere. A sharp boundary exists because the molecular scattering of light prevents the view at the center of the sun's disc from penetrating more than perhaps one thousand kilometers. A view at the sun's edge will be oblique, and to furnish gas one thousand kilometers thick

there will mean a thickness radially of only perhaps one hundred kilometers, which implies an indistinctness of outline of less than a half second of arc, which is not discernible. In consequence of the deeper source of the observed radiation the effective temperature of the source at the center of the sun's disc exceeds that at the sun's edge. Hence the intensity of the radiation falls off from the center to the edge. The diminution of the effective temperature of the source affects short wave rays more powerfully than longer ones, hence the contrast between edge and center is greater for violet than for red, as long known. The granulation of the sun's disc the speaker regarded as evidence of slight differences of temperature from place to place, with attending differences of radiation. He called attention to the fact that such differences of brightness appear most strongly in spectroheliographic photographs with the red hydrogen line, where of course it is out of the question that the effect is due to the precipitation of a cloud. But it is stated by some that the juxtaposition of the gases to empty space must necessarily cause a precipitation of a cloud by cooling. The speaker drew attention to the existence of water vapor without clouds in many regions of the earth's atmosphere, and to the existence of steam without a cloud for some distance above the stack of a locomotive. The question of cloudy precipitation depends upon the rate of supply of heat to take the place of energy radiated away, and on the rate of change of density of the gas at the boundary. A cloud is not a necessity. Many other points were discussed.

(The foregoing abstracts are by the respective authors of the papers.)

R. L. Faris,
Secretary

THE GEOLOGICAL SOCIETY OF WASHINGTON

At the 238th meeting of the society, held at the Cosmos Club on Wednesday evening, January 25, 1911, under informal communications, Mr. C. W. Hayes exhibited a series of specimens illustrating the growth of concretions of different composition under a variety of conditions.

(*a*) Calcite concretions from the famous Dos Bocas oil well, south of Tampico, Mexico. This well now forms a great caldron about 36 acres in extent. The ebullition due to the escape of gas, which a year ago was continuous, is now intermittent, having a period of about two hours. The well still yields a large quantity of hot (160° F.) salt water heavily charged with lime and a small amount of heavy oil in the form of a frothy emulsion. The water deposits lime carbonate partly in concretionary form. The concretions, from .5 to 1.5 inches in diameter, being kept in motion by the ebullition in the caldron are almost perfect spheres, made up of very thin concentric layers.

(*b*) Bauxite concretions from the Rome district in northwest Georgia. The formation of these deposits has been ascribed to hot spring action and the conditions during their deposition were probably analogous to those seen in the Dos Bocas well. Instead, however, of being charged with lime in solution, the water contained aluminum hydroxide in suspension and this was deposited in concentric layers forming the bauxite concretions.

(*c*) Calcite concretions from San Antonio, Tex. These occur in great abundance in the "telpetate" or "caliche," a widespread chalky limestone formation, produced at or near the surface in semi-arid limestone regions by the ascent of water through capillary action and evaporation with deposition of the dissolved salts. Ordinarily the deposit has a platy structure, but in places, as at San Antonio, it is strongly concretionary.

(*d*) Bauxite concretions from the Little Rock district, Ark. These deposits are similar in form and possibly analogous in origin to the telpetate of San Antonio. The concretions are nearly indistinguishable from those of San Antonio, although entirely different in composition.

Regular Program

The Topographic Development of the Catskill Mountains: H. E. Merwin.

The Catskill Mountains and the adjacent region have the structure of a coastal plain with a very resistant thick member at the top. The Hudson-Mohawk valley developed as a subsequent valley in the weaker lower member that outcropped along the borders of the Adirondack-Taconic old land. The Hudson became superposed upon the complex structure of the Highlands which were buried beneath the coastal plain series. This river seems to have had its course well established by the close of the Paleozoic so that it was antecedent to the folded structure beneath and east of the Catskills.

The topography of the northeastern Catskills, though originally of the peak and spur type characteristic of mature plateaus, is now strongly influenced by the southward dip of the rocks. The drainage of this part of the Catskills was originally westward through the Delaware and Susque

hanna rivers, but long after the uplift of the Cretaceous peneplain the Schoharie captured this drainage.

In the southern and western Catskills the streams are still working in massive rocks, developing the plateau type of topography

The Iron Ores of Sweden WALDEMAR LINDGREN

Mr Lindgren discussed nature and origin of the principal iron ore deposits and exhibited numerous specimens

EDSON S BASTIN,
Secretary

THE BOTANICAL SOCIETY OF WASHINGTON

THE 71st regular meeting was held at the Cosmos Club, Tuesday, March 7, 1911, at 8 00 P M President W J Spillman presided Thirty two members were present Mr H C Skeels was elected to membership

Mr W A Orton discussed current dictionary definitions of the term "genetics" and showed that the usage attributed to Ward in the new Century is faulty, as that author proposed the term as an antithesis of "telics" and did not extend it to other phenomena of evolution The usage in the new Webster was held to be faulty in that it does not convey the new view point of scientific experimentation The term was thus newly defined "*Genetics*—the application of scientific methods to the study of evolutionary problems, the investigation, in an exact manner and by experimental means, of the facts pertaining to heredity, variation and allied subjects"

The following papers were read

Studies of the Life History of the Head Smut of Sorghum ALDEN A POTTER

Attempts at preventing this smut by seed treatments have failed Numerous inoculation experiments have been performed, but neither local infection, as in corn smut, seedling infection, as in the kernel smuts, nor floral infection, as in the loose smuts of barley and wheat, has been demonstrated No theory of local infection can be entertained, however, since detailed histological study has shown that the host plant is affected as a whole Since the infection is general, then, it must take place at an early stage

Peculiar floral alterations were shown to be caused by the smut and to contain the smut mycelium, and it was suggested that some grains may develop with the fungus in them and the smut, therefore, be hereditary as is the fungus in certain *Lolium* species

Dimorphic Leaves of Cotton and Allied Plants O F COOK

This paper reported the existence of a definite dimorphism of leaves in an Egyptian variety of *Hibiscus cannabinus* The basal leaves are simple, but there is an abrupt transition to deeply lobed leaves near the middle of the stalk A second Egyptian variety has all the leaves simple Parallel variations of leaf forms exist in cotton, okra and *Ingenhousia*, a wild relative of American upland cotton, found in Arizona and Mexico The so called okra varieties of upland cotton, with narrow lobed leaves, correspond to the dimorphic Egyptian variety of *Hibiscus cannabinus* Hybrids between okra cottons and broad leaved varieties have shown intermediate forms of leaves in the conjugate generation and Mendelian segregation in the perjugate generation Dimorphism and Mendelism were treated as analogous forms of alternative expression of characters, the current theory of alternative transmission being considered unnecessary

Plant Remains Composing Coals DR R THIESSEN

A brief review of the literature on the microscopic investigations of coals was given, in which the views of Bertrand and Renault and Potonié were dwelt upon

Since every interpretation of any investigation must agree with every known scientific fact, in the present investigation on coal the structure, organization, morphology and chemistry of the living as well as of fossil plant forms had to be considered Plant components of coals may be divided into two classes those less resistant to chemical agencies, and those less easily or very difficultly attacked by such agencies Among the latter class may be recounted the lignocelluloses, the true celluloses, the cuto celluloses, especially the leaf cuticles, spore and pollen exines, the resins and the waxes It has been found that the coals are composed in a large proportion, if not entirely, of this class

The lignites are composed approximately of from 75 to 85 per cent of stems, branches and twigs, almost entirely of coniferous origin, in a very much vertically compressed and changed condition, the interstices being filled in with a plant refuse, analogous to a recent black peat, in which resins, pollen exines, spore exines, cuticles and waxes form an important part These constituting a crystalloid component are imbedded in a colloidal substance, mainly a derivative of cellulose Here as in all the coals, nothing but the outer wall or

exine of the spore and pollen grains is now left, and of the leaves nothing but the cuticle, rarely the epidermis, is left.

The brown coals from Lester, Ark., are composed of a "débris" only, in which the crystalloid components form a very large proportion, fern spore exines also are very abundant. To these constituents must be ascribed the oil yielding properties of this coal.

In the bituminous coal from Exeter, Ill., the "wood" is represented mainly by thin, jetty, black, lamina, between which is found a component closely resembling the débris of the younger coals, having as a ground substance a much macerated woody or colloidal material in which a greater proportion of crystalloid substances are imbedded. All the elements found in the younger coals and also megaspores are represented. The bituminous coal from Shelbeyville is very similar but has a much greater proportion of crystalloid material, megaspore exines and cuticles.

The cannel coals examined are composed almost entirely of spore exines of a variety of forms, resins and cuticles are present only in a very subordinate amount. The so called binding matter in the interstices of the spore exines is distinctly composed of two kinds of substances, one more or less homogeneous, colloidal in nature, and the other more or less granular, the fragmentary residue of spore exines.

The algal theory of Bertrand and Renault, and the sapropellic theory of Pontonié were rejected as being undemonstrable in every particular. The bodies supposed to be algæ can be shown not to be algæ, and all but one kind have unmistakably been proved to be the exines of certain spores, either of Pteridophytes or Cycadofilicales or both. A gelosic substance, such as the algal theory calls for, is entirely absent.

W. W. Stockberger,
Corresponding Secretary

THE ANTHROPOLOGICAL SOCIETY OF WASHINGTON

At the 452d meeting of the board of managers, held March 23, 1911, the following resolutions submitted by the undersigned committee were adopted by the board and ordered published in Science.

"Acting on the information furnished by one of its members, Dr. Aleš Hrdlička, in regard to the wholesale destruction of antiquities in all parts of Peru, as well as in other regions of South America, the Anthropological Society of Washington has, after due consideration, resolved that

"1. The remains of American aborigines, wherever met with, and particularly in such countries as Peru, where native civilization reached high standards, are historical records of definite branches of the human family and, as such, are of great value to science, to the country in which they exist and to mankind in general.

"2. In view of such value of the remains in question, which include all manifestations of human activity, and also the associated skeletal parts of man himself, the destruction of these records is deprecated and the hope is expressed that scientific men and societies, as well as the proper authorities, will counteract the same as far as possible."

W. H. Holmes,
A. Hrdlička,
Walter Hough,
Committee
I. M. Cassanowicz,
Secretary

THE AMERICAN PHILOSOPHICAL SOCIETY

Dr. F. M. Jaeger, professor of inorganic and physical chemistry and head of the department of chemistry in the University of Groningen, Holland, gave an illustrated lecture "On Fluid Crystals and Anisotropic Liquids" before the American Philosophical Society on March 3. He explained why this question was one of the most ardently discussed problems of physical chemistry at present, how the old conception as to the molecular movement of the liquid state can not hold in the face of the newly discovered facts. He pointed out the close analogy between these phenomena and the polymorphic changes of matter and discussed the properties of substances melting successively to two, three or more liquid states. He demonstrated the principal physical properties of the above substances, their birefringence, magnetic induction, surface-tension and circular polarization. He discussed the so called "emulsion theory" and proved its valuelessness for the explanation of the different phenomena.

In short, it is proved now undoubtedly that liquids can share the characteristic properties of crystalline matter and that they display phenomena which indicate a regular molecular movement in the liquid state. The whole subject is of the highest importance both for physics and for chemistry.

SCIENCE

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THE ORIGIN OF THE THERMAL WATERS IN THE YELLOWSTONE NATIONAL PARK[1]

INTRODUCTION

FROM the earliest days of systematic geological research thermal springs have been a frequent subject of investigations by students of natural phenomena. From time to time numerous contributions to scientific literature bearing upon the nature of hot springs, partly descriptive and in part theoretical, have been presented to learned societies. Nearly all regions where such waters issue from the ground on an imposing scale appear to have been at one time or another scenes of eruptive energy. In so many instances has this been shown to be the case that thermal activity and volcanic manifestation have come to be regarded as associated phenomena. It by no means follows, however, that the original source of all these waters was, geologically speaking, deep-seated, and by a large school of geologists it has never been so regarded. In recent years the results of several suggestive researches have been published, in which the position is taken that superheated waters from igneous rocks are primitive in their origin, that is to say, they are derived from great depths in the earth's crust and are brought to the surface for the first time by volcanic forces.

The Yellowstone National Park affords one of the most remarkable, and probably one of the most instructive areas of thermal springs and geysers to be found in the world. The varied phenomena of boiling springs and aqueous vapors there stand unsurpassed. Several years ago, after a

[1] Annual address of the president, before the Geological Society of America, December 27, 1910.

study of the region under the auspices of the United States Geological Survey, I published in official documents, and later in Johnson's "Universal Cyclopædia," an article entitled "Thermal Springs," in which I stated the conclusion that the waters of these hot springs and geysers were essentially meteoric waters that had penetrated downwards a sufficient distance to attain an increased temperature, only to be forced again to the surface by ascending currents.

I propose on this occasion to present briefly some of the geological evidence on which these conclusions are founded. They are based on the nature and structure of the rocks through which the heated waters reach the surface, the mineral constituents contained in the waters, the composition of the associated gases, and the characters of the varied sediments and incrustations deposited around the springs and pools.

EOCENE IGNEOUS ROCKS

To understand correctly the relations of the thermal waters found in the park to existing geological conditions, a brief history of the salient features of its igneous rocks and their sequence seems necessary. The country included within the Yellowstone Park, the Absaroka Range, and the Wind River Plateau, consists essentially of masses of igneous rocks covering an area of over 5,000 square miles in the center of a continent whose three great rivers, the Mississippi, the Colorado, and the Columbia, here find their source. Within this region, through that vast period of time from the close of the Archæan to the dawn of the Tertiary, all evidences of eruptive energy are wanting. Coincident with the earliest indications of the post-Laramie orogenic movement came a period of intrusion which began in late Cretaceous time and continued with only slight periods of rest till near the end of the Pliocene. Whatever the primary causes were that produced this orogenic movement, the enlargement of the continental area, and the final withdrawal of the sea, they brought about mountain uplifts, crustal displacements, and volcanic activities of the first magnitude. The close of the Cretaceous in this part of the northern Cordillera was marked by the most profound stratigraphic break since Algonkian time. The oldest intrusives, recognized as such, are found in the northwestern corner of the Yellowstone park in what is now the Gallatin Range, and inaugurated a physical revolution. These rocks were forced in as sills between upper Mesozoic sandstones before the latter were much disturbed, as they lie unconformably interbedded between sediments which later were affected by the dynamic processes of mountain elevation. In this sense these earliest intrusions must be considered, structurally at least, as of Cretaceous age. They were succeeded by more powerful injections, accompanied by slow and protracted elevation of the Gallatin Range. With the emergence of land surfaces erosion followed and sediments were deposited unconformably. Elevation of mountain masses produced new physiographic features, and as a consequence changes in climatic conditions and modifications of living species, both animal and vegetable. The Tertiary period was ushered in. With the progressive building up of the range and the associated folding and compression of strata, viscous magmas were injected from unknown depths. Massive bodies were forced upward to definite levels, when, being unable to rise higher, they spread out laterally between strata of all ages from the Cambrian to the Laramie. Centers of powerful intrusion shifted from one locality to another, and within the confined limits of the range batholiths of no

mean proportions were forced upward Evidence is wanting to show that any of these magmas in their upward movement ever penetrated to the surface, apparently they came to a standstill far below a covering of overlying sediments whose thickness must, for the present at least, remain a matter of conjecture Excessive erosion since early Eocene time has laid bare these massive batholithic forms which now stand out as dominant features in the landscape

There is no evidence to warrant the opinion that these porphyries and crystalline rocks were ever connected with vents discharging lavas, though there is, beyond the boundaries of the Gallatin Range, extravasated material of Eocene age covering large tracts of country In the northeast corner of the park such surface flows are well developed in the accumulation of silts and ashes Much of this material was laid down under relatively quiet conditions Apparently they are much later than the crystalline rocks already referred to, but their age is determined by a characteristic flora corresponding with the well-known Fort Union beds of Montana of Eocene age

In these extravasated lavas the influence of volcanic waters may be recognized in many ways, but degradation of the mass has been so great that evidence of individual extinct hot springs is no longer traceable, moreover, it would seem impossible to distinguish them from those belonging to Miocene eruptions

MIOCENE IGNEOUS ROCKS AND THERMAL WATERS

The Absaroka Range shuts in the park plateau along its eastern border Strictly speaking, it is not a mountain range, but rather a rugged, deeply dissected tableland, rising from 3,000 to 4,000 feet above the general level of the park It stretches for eighty miles in a north-and-south direction and measures nearly fifty miles in width In strong contrast to the Eocene igneous rocks this elevated tableland was steadily built up by tumultuous accumulations of breccias, agglomerates, silts and muds, the products of violent explosive action through numerous conduits from sources now concealed beneath the overlying load Nearly all phenomena of ejected lavas seen in extinct volcanic areas elsewhere may be observed here Finally, the mass was penetrated by batholithic intrusions, accompanied by innumerable dikes and sills, offshoots from the parent stock All this was the result of long-continued, protracted energy, as clearly shown both by geological processes and the many successive fossil forests These flourished through thousands of feet of eruptive material and were alternately killed by hot fragmentary lavas and preserved by renewed streams of muds and ashes[2] The luxuriant vegetation which developed throughout this period is regarded by all paleobotanists as of Miocene age All volcanic activity long since ceased

What concerns us most at the present time is the influence of thermal waters derived from deep-seated sub-crustal sources upon both the volcanic ejectamenta and crystalline intrusives The action of these heated waters may be observed equally well on what were surface flows and on the deeply buried intrusive masses Such surface action may be detected at a number of localities by the presence of alteration products and traces of sediments, although in most cases the latter have been removed by running water Underground action of sub-crustal waters is shown in many

[2] Arnold Hague, "Early Tertiary Volcanoes of the Absaroka Range," presidential address, Geol Soc of Wash, 1899, SCIENCE, March 24, 1899

places from one end of the range to the other by deposits laid down from ascending igneous emanations in the form of aqueous and gaseous vapors charged with mineral matter Such deposits consist essentially of quartz, galena, and copper minerals, carrying both gold and silver They lie as contact products along the apophyses of the massive intrusions and never occur far away from them They were deposited after the crystalline intrusives came to a state of rest, but probably long before they were chilled It may not be necessary to add, but it should be borne in mind, that at the time of deposition they were much farther below the surface than they are found to-day Mining companies have exploited the ores by shifts and tunnels, but so far as I know, such ore bodies have never proved lucrative, owing to their uncertainty and lack of continuity Similar ore bodies in the mining regions of Montana and Colorado have been described by Emmons, Lindgren, Weed, Kemp, and others

Another feature of these intrusive rocks of the Absarokas is seen in the narrow rifts and shrinkage cracks filled with quartz by the ascending currents from deep-seated sources In like manner the cavities and druses found in the petrified trees of the fossil forests are lined with quartz crystals, due to heated siliceous waters coming up from below To-day there are no hot springs or steam vents to be found in the Absarokas, save in a feeble way on the western flanks, where the ancient breccias have been penetrated by much later rhyolites

It has seemed necessary to present this somewhat lengthy description of volcanic forces existing in Miocene time in order to bring out in strong contrast the conditions prevailing during Pliocene and recent times

PLIOCENE IGNEOUS ROCKS AND THERMAL WATERS

After the pouring out of the basic breccias and lavas of the Miocene, volcanic energy, for a time at least, ceased Atmospheric agencies removed a large body of the surface rocks and carved out drainage channels in the easily disintegrated material Following a prolonged interval of comparative rest came renewed activity, with marked changes in the nature of the eruptive lavas Vast masses of rhyolite were extruded, not upon preexisting mountains, but over an enclosed basin, converting it into a rugged tableland and submerging the flanks of the bordering ranges This sharply defined region has been designated as the Park Plateau It embraces a tract of country fifty by forty miles, including approximately 2,000 square miles Strictly speaking, it is not a plateau in the general acceptation of the word, but presents a broken surface accentuated by bold escarpments and abrupt slopes of lava flows While the topography of the tableland has, to some extent, been modified since Pleistocene time and trenched by ice action, giving the effect of individual plateau blocks, the mass can not be considered otherwise than as a geological unit The earliest rhyolitic eruptions spread over a very uneven surface, the structural features of which may be fairly well inferred from exposures of sedimentary rocks rising through the surrounding lavas or cropping out from beneath the outer boundaries of the plateau The rhyolite also lies unconformably upon the eroded surfaces of basic breccias, and not infrequently occupies the older valley bottoms, clearly showing the much later age of the siliceous lavas Although sharply defined by topographic relief and geological sequence, both periods of ejection are still more strongly contrasted by marked dif-

ferences in the phases of eruption which built up the two volcanic regions

On the rhyolite plateau there are no evidences of violent explosive action The complete absence of true volcanic breccias is a significant feature of these later flows Dikes, veins and horizontal sills, together with nearly all the phenomena of deep-seated intrusions, are wanting The rhyolite shows scarcely any indications of hydrothermal activity during eruption In the abrupt escarpments made up of successive sheets there are no signs of surface flows having been exposed to long-continued atmospheric agencies, no wind-strewn ashes or any vestiges of vegetation On the contrary, everything clearly indicates a relatively rapid accumulation of viscous masses from the beginning to the end of the rhyolite period What impresses one most is the absence of stages of activity with intervals of quiescence, there being rather a series of massive eruptions piled up one upon another In the central portion of the park the rhyolites have a maximum thickness of 2,000 feet, and over large areas they may be assumed to measure 1,500 feet

Subsequent to the rhyolites and the building up of the park plateau came a few dikes and thin sheets of basalt They are the most easterly occurrence of those broad basaltic flows that spread over southern Idaho and the Snake River plain In the park country they are of Pliocene age, that is to say, they are older than the glacial ice They make the final chapter in the history of Tertiary igneous rocks As they play no recognized part in the problems bearing upon thermal waters they may be dismissed at the present time with this brief mention

Unquestionably the Pleistocene age, with its changed conditions, set in not long after the dying out of rhyolitic eruptions, as is shown by the relatively slight erosion of the plateau and the beginning of canyon sculpturing All geological evidence tends to prove that the rhyolites belong to the Pliocene age

DURATION OF THERMAL ACTIVITY

That the activity of thermal waters was approximately coincident with the cessation of rhyolite ejections is, fortunately, clearly proved by the massive horizontal beds of calcium carbonate laid down on the summit of Terrace Mountain, where they attain a maximum thickness of nearly 250 feet, although the average is much less Without doubt they are the oldest deposits of travertine in the region of Mammoth Hot Springs, and rest directly upon fresh, unaltered rhyolite Glacial ice from the Gallatin Mountains moving eastward occupied the intervening Swan Lake Valley and passed over the top of Terrace Mountain on its way to the broad, open valley of the Yellowstone On the recession of the glacier fragments of crystalline rocks, undoubtedly brought down from the Gallatin country, were left strewn over the travertine of Terrace Mountain

It is a fair assumption that if these thermal waters were issuing through rhyolite at one locality in pre-glacial time, similar hot waters and gaseous emanations should have reached the surface at other points on the plateau If any such remnants of sinters still remain it seems impossible, from our present knowledge, to discriminate between them and those of post-glacial time Erosion has carried away not only every trace of these earlier deposits, but has removed nearly all evidences of pre-glacial rock decomposition Modifications in topographical relief fail to indicate two distinct periods, owing probably to the relatively slight deposition of sinter before the ice

Following the withdrawal of a broad ice sheet, ascending heated waters, acting with renewed energy upon the walls of innumerable fissures and rifts, bleached and kaolinized massive blocks of rock. This decomposition of plateau lavas proceeded on a grand scale and left an indelible impression upon the rhyolite areas. In regard to the age of the hot springs it is reasonable to conclude that thermal waters were as active at the close of the rhyolite extrusions as at any subsequent period. The antiquity of many localities of decomposed rhyolite is clearly evident, as shown by post-glacial sculpturing. In certain areas where hydrothermal energy was formerly a long-continued process, evidence of the presence of such sources of heat have long since ceased. No one who has studied the gradual development of these decompositions and metasomatic changes under the influence of acid solfataras, or the deposition of sinter now taking place from alkaline siliceous waters, can doubt the lapse of time required by these geological agents to accomplish the results observed. Such processes can not, however, differ essentially other than in degree from those observed to-day. In my opinion, they have never ceased to be active and have only varied in intensity from time to time. It meets all the requirements, therefore, for our present purpose, to consider the phenomena now taking place or since the hot springs and geysers were first brought to the attention of the scientific world, about forty years ago.

CLIMATIC CONDITIONS

Precipitation of moisture over the plateau and encircling mountains is far heavier than that taking place over the semi-arid regions below. Not only is the rainfall higher for every month of the year, but the temperature is correspondingly lower. Four large rivers, the Yellowstone, Snake, Madison, and Gallatin, carry the waters from the uplands to the lowlands. Knowing the amount of water leaving the park by these principal drainage channels, it is easy to estimate approximately the total amount of surface waters carried away.

Meteorological records, more or less complete, have been kept at Mammoth Hot Springs for over a quarter of a century, and during one winter at the Firehole Basin. From these data an approximate estimate can be made of the water falling over the entire region. Some years ago instrumental measurements were undertaken during the summer to determine the amount of evaporation on the open sinter plain in the Upper Geyser Basin. Similar observations were made at the outlet of Yellowstone Lake. Taking into consideration the annual precipitation and run-off, and the summer evaporation, I believe the supply of water greatly exceeds the amount carried away by surface streams. Climatic conditions, as they exist in the park to-day, favor forest development and a varied undergrowth. It is estimated that over 82 per cent. of the region is forest-covered. For eight months precipitation occurs in the form of snow, which, protected by the forests from the sun's rays and the drying winds, melts slowly and lingers on well into midsummer. On the adjoining mountains the snow seldom entirely disappears. The retention of the water by forest and undergrowth brings about the development of the many meadows, marshes and bogs. Scattered over the tableland occur frequent ponds and lakelets, carrying in the aggregate a very considerable body of water. In this connection may be mentioned such large reservoirs as Yellowstone Lake, covering over 125 square miles of surface, and Sho-

shone Lake, measuring 12 square miles, to say nothing of other picturesque sheets of water of less imposing dimensions, all of which lie upon the rhyolite from 500 to 700 feet above the Upper Geyser Basin, where the greatest number of large geysers is found and the activity and overflow of thermal waters displayed on a grand scale. In time, much of the water from the meadows and ponds naturally finds its way to surface streams. Another portion is taken up by the luxuriant vegetation or is absorbed by the atmosphere. The remaining water, which constitutes a very considerable volume, is drawn down through openings into underground reservoirs. In other words, these descending waters slowly percolate through the viscous lavas.

PHYSICAL STRUCTURE OF RHYOLITES

Returning for a few brief moments to rhyolite flows, let us consider certain physical features due to textural modifications. No region surpasses the Yellowstone Park in the varied phenomena of highly acid extrusions. This is especially true of the more glassy types, and in general a glassy ground mass characterizes most of these lava sheets. Mr. J. P. Iddings has submitted a large series of specimens of the park rhyolites to a searching petrographical investigation, making a special study of the microgranular structure, and the relations of the different microstructures to one another, and pointing out the abrupt transitions from the glassy to the crystalline and from the pumiceous to lithoidal forms. For further details the student is referred to this admirable work. In conclusion, Mr. Iddings calls attention to the agency of water in bringing about the varied products. He says:

> The heterogeneity of the acid lavas so far as known is confined to the distribution of vapors, presumably of water, and suggests that the water thus irregularly disseminated has not existed within the magma long enough to become uniformly diffused. It must therefore be looked upon as water absorbed near the earth's surface.[8]

From the point of view of the present discussion the cause of these remarkable structural variations concerns us less than the influence exerted by such textural modifications in the creation of fissures, fractures and capillary openings for the percolation of waters. Obsidians, perlites, and pitch-stones were poured out over the greater part of the central plateau and may be found at the base of bold escarpments, under accumulation of successive flows. Glassy forms present as marked a feature of many of these earlier outpourings as they do of the more recent flows. They were surface flows when ejected. They prove conclusively, on geological evidence, that similar physical conditions were identical from the beginning to the close of the rhyolite phase of eruption. The liquidity of the magma and its crystallization changed from time to time, being dependent upon varying causes, such as the degree of temperature when ejected from the point of discharge, the volume of the mass, and the power of the lava to hold its contained heat.

Banded and laminated lavas, contact surfaces between magmas of different physical properties, shrinkage cracks and jointings in obsidian and perlite, overlapping of lava flows, all caused numerous narrow capillary spaces in the rock. Some of these openings for short distances lie parallel with the lava flows, others are vertical along planes of jointing, while still others indicate great irregularity, broadening and contracting along a circuitous course. Uniting below the surface, they develop into wider channels, affording free circu-

[8] J. P. Iddings, "Geology of the Yellowstone National Park," Mon. XXXII., Part II., p. 425.

lation of either descending or ascending waters

MINERAL AND CHEMICAL COMPOSITION OF RHYOLITE

As I hope to be able to show that the mineral matter brought to the surface in solution by ascending thermal waters circulating through rhyolite is mainly derived from these lavas, it is necessary to examine in detail both their chemical and mineral composition The chemical composition of the rhyolite appears remarkably uniform when the enormous bulk is considered and the different physical conditions under which the lava streams were extravasated

In the subjoined table will be found analyses of eleven specimens of rhyolite, arranged according to their tenure of silica They were made in the laboratory of the United States Geological Survey, but are here brought together in tabular form ties, but, curiously, analysis fails to show the presence of both in the same flow Traces of manganese have been detected in many specimens from widely separated parts of the tableland, which is interesting from the fact that in one or two localities solfataras have deposited manganese oxide as dendritic incrustations Considering the rhyolite as a homogeneous mass the composition of the molten magma is probably best shown in the specimen from Madison Canyon Here the silica percentage was 75 2 per cent, the alumina 13 77, and the combined potash and soda 7 16

As regards mineral composition the rhyolite is by no means as simple, owing to textural modifications that range from semitransparent, amorphous obsidian, to liparite with relatively little ground mass Nevertheless, the species that have crystallized out from the magma are few in number, the only essential rock-making minerals being quartz and sanidine In certain lavas quartz, in irregular crystals, occurs abundantly disseminated as megascopic phenocrysts while in others it is wholly wanting Plagioclase stands next in order, being easily recognized in many thin sections under the microscope, although being seldom recognized by the naked eye This is probably owing to the small amount of alkaline earths present Small flakes of biotite have been detected here and there, but in the typical rhyolite

ANALYSES OF RHYOLITES FROM YELLOWSTONE NATIONAL PARK

		SiO_2	TiO_2	Al_2O_3	Fe_2O_3	FeO	MnO	MgO	CaO	Na_2O	K_2O	Li_2O	P_2O_5	SO_3	H_2O	Cl	Total
I	Upper Geyser Basin	70 92	16	13 24	3 64	66	14	23	1 12	4 28	4 25	—	18	—	57	—	99 59
II	Head of Tower Creek	71 85	48	13 17	2 17	1 34	12	63	2 25	4 06	3 69	—	14	—	43	—	100 48
III	Plateau east of Willow Park	72 59	52	13 47	1 58	1 32	Trace	1 05	2 12	4 63	2 52	—	None	—	18	—	99 98
IV	Cliff east of Excelsior Geyser	73 84	—	12 47	92	90	Trace	25	1 08	2 88	5 38	—	—	—	2 76	—	99 88
V	Obsidian Cliff	74 70	None	13 72	1 01	62	Trace	14	78	3 90	4 02	—	None	—	62	10	100 81
VI	North Madison Plateau	75 19	None	13 77	61	1 37	Trace	09	68	3 83	3 33	02	None	29	65	—	99 83
VII	Elephants Back	75 34	None	12 51	42	1 55	07	32	1 07	3 31	3 17	Trace	None	42	88	—	100 01
VIII	Obsidian Cliff	75 50	None	13 25	1 02	91	None	07	90	4 76	2 85	06	None	32	41	—	100 05
IX	Obsidian Cliff	75 52	None	14 11	1 74	08	None	10	78	3 92	3 63	—	None	—	39	11	100 49
X	Sheridan Volcano	75 89	50	12 27	1 12	1 87	None	29	86	3 21	3 42	01	None	28	52	—	100 06
XI	Sherman Volcano	77 65	14	11 50	1 21	26	None	—	50	3 33	4 85	—	02	—	28	—	99 84

In five analyses the range in silica falls within seven tenths of a per cent Lime and magnesia show the greatest variation, while the alkalies do not appear to be higher than in many other localities where rhyolite has been extravasated in the form of massive eruptions Titanic oxide has been determined in small amounts, but was not detected in the obsidians or in any of the extreme glassy rocks On the other hand, both sulphuric acid and chlorine occur in small quantities in the fresh glassy varieties, but, curiously, analysis fails to show the presence of both in the same flow

it may be said to be absent Pyroxenic minerals are rare and only in microscopic crystals Magnetite is somewhat more widely distributed, but only in minute grains, as might be supposed from the low percentage of iron oxides The presence of titanium in the magma reveals itself in the disseminated grains of ilmenite and pseudobrookite Apatite, zircon, and allanite complete the limited list of accessory minerals

CLASSIFICATION AND COMPOSITION OF THERMAL SPRINGS

The number of springs scattered over the park, from which flow varying amounts of thermal waters, probably exceed twenty-five hundred If to these be added the fumaroles, solfataras, and narrow rifts from which issue steam and gaseous emanations mingled with more or less water, the number would be greatly augmented It is impossible to enumerate them, as new ones are frequently reaching the surface, while others are slowly becoming extinct Furthermore, it would be no easy task to decide whether single points of discharge should be counted, or considered as a group having a common source a short distance below ground These thermal waters reach the surface holding mineral matter in solution, derived from the decomposition of rocks through which they pass in their upward movement They may be arranged under four heads (1) waters carrying calcic carbonate in solution, (2) siliceous alkaline waters rich in dissolved silica, (3) calcic siliceous waters having both properties of calcic carbonate and siliceous alkaline springs, (4) siliceous acid waters, usually holding free acid in solution

Nearly thirty of these thermal waters have been analyzed by F E Gooch and J E Whitfield in the laboratory of the United States Geological Survey and the results published in a separate bulletin[4]

Among these waters are several from the Mammoth Hot Springs characterized by the large amount of calcic carbonate in solution, associated with free carbon dioxide and sulphates of magnesium and the alkalies Underground conditions were doubtless favorable for holding in solution large amounts of calcic carbonate With the relief of pressure at the surface and the diffusion of free carbon dioxide, precipitation followed, as shown in the deposits which have made the Mammoth Hot Springs so famous From the present point of view we are not so much concerned with depositions from these waters as with the waters themselves and their geological relations, since they unquestionably have a common source with those of the rhyolite plateau

At the Mammoth Hot Springs the upper lava flows lie directly against inclined Jurassic limestones The circulating hot waters having been diverted in their course, traverse the limestone before issuing at the surface Apparently the waters derive a large part of their mineral constituents from the limestone In contrast to the hot waters of the plateaus they carry but little silica in solution Far to the southward, where the rhyolite tableland ends, the attenuated lava streams also rest against uplifted limestones Calcic carbonate springs, although of modest dimension, issue through the rhyolite, but have derived their mineral contents mainly from the adjacent limestones Both the carbonated waters and the travertine deposits resemble those at Mammoth Hot Springs Similar geological relations may be observed near the eastern

[4] F A Gooch and J E Whitfield, "Analyses of Waters of Yellowstone National Park," Bull U S Geol Survey No 47, Washington

limits of the rhyolite at Soda Butte Spring, and again near the western border

On the other hand, wherever the heated waters issue from the rhyolite of the tableland they are characterized by a high percentage of silica These waters occur distributed over a wide area and furnish the great volume of water discharged from the geysers and hot springs, and for this reason have excited more general interest than the smaller springs They have supplied the silica for the many square miles of glittering white sinter plains For the most part they are siliceous alkaline waters, as in the Upper Geyser Basin and the Firehole Basin They may, however, be slightly acid or neutral, as in the case of many of them in Norris Basin

The silica occurs in solution as hydrated silica associated with carbonates and chlorides of the alkalies, together with small quantities of sulphates Arsenic and boron have been determined in nearly all geyser waters, probably combined with soda as arsenates and borates Traces of bromine, phosphoric acid, soda, manganese, lithium, cæsium and rubidium were detected in several instances, but lithium and bromine are the only elements present in sufficient quantities to allow of estimation Tests were made for titanic acid, nitric acid, iodine, fluorine, barium, and strontium, but none of them were found Special examinations were made in concentrated solution for tin, copper, and lead, but no one of them was present In this connection it may be pointed out that while veins carrying lead, copper, and silver are found associated with Eocene and Miocene igneous rocks, these metals have never been detected in either the rhyolite or waters of the park

A study of these chemical analyses brings out clearly the marked differences in percentages of substances held in solution, especially silica, even in adjoining geysers. This holds equally well for the siliceous alkaline waters from the same geyser basin as from those collected from different localities Waters examined the same year show as great variations as those collected one or two years apart The silica, as determined by analysis, ranges from 22 to 67 gram per kilogram of water, the former being the amount found in the cauldron of the Excelsior, having the largest outflow of any pool in the park, and the latter from Opal Spring in Norris Basin, with but slight run-off, and without any apparent inflow The cause of these differences is, I believe, to be sought in the varying amounts of infiltrating surface water

Dr W H Hallock has shown conclusively, by experimental tests with self-registering thermometers, that the thermal waters stored in underground geyser reservoirs possess a temperature far in excess of the boiling point at the surface, due to increased pressure of the overlying column of water in the geyser tube The results were in accord with the theoretical boiling point It can not be affirmed positively that these superheated waters maintain the same composition after being thrown out as the underground waters at greater or less depth or even with those of the geyser reservoirs On the other hand, there exists no evidence of chemical changes due to relief of pressure before the waters reach the surface through geyser orifices

Upon the relief of pressure, hydrated silica, associated with traces of an equally insoluble silicate of alumina and lime, is deposited upon the broad plains of the geyser basins Nearly all remaining constituents are carried away in solution by surface streams Although the composi-

tion of the deposited sediment is everywhere much the same, its external habit varies with the manner of its secretion, which may have happened in several ways It may have been caused by precipitation on relief of pressure, precipitation on cooling, separation by evaporation, and assimilation by algæ Mr Walter H Weed has shown conclusively the important part such organisms perform as geological agents in the accumulation of sinter deposits [5]

The volume of siliceous alkaline waters far exceeds those of the acid type On the other hand, the latter occur more widely distributed, are more complex in their composition, and consequently more varied in their deposits These acid waters come to the surface through fumaroles, solfataras, and the so-called mud springs and paint pots In nearly all such occurrences the waters carry either free hydrochloric or sulphuric acid In general these thermal waters, which rise through narrow seams and rifts, run but little water and leave behind only thin incrustations around the sources of supply These deposits are found widespread over the park and consist principally of sulphates of alumina and double compounds of alumina and iron While they show a mingling of saline compounds carrying more or less silica as an impurity, the number of mineral species remains singularly few Halotrichite, alunogen, and alum are the only minerals of the alum group determined In the far more arid regions of New Mexico accumulations of these minerals have been described by Dr C W. Hayes[6] as deposits from aqueous solutions associated with igneous rocks

Under quite different conditions, and as thin layers deposited below water level in the Norris Basin, occur incrustations of both sulphides of arsenic—orpiment and realgar They are, however, very restricted in quantity Scorodite, delicate crystals of sulphur, and ochreous deposits, mainly ferric oxide and silica, are characteristic of certain acid and neutral waters These sediments and incrustations point clearly to different conditions of thermal activity In strong contrast from those described in connection with siliceous alkaline waters they indicate an earlier stage in the development of rock decomposition

GASES FROM THERMAL SPRINGS

Several years ago gases emitted from many of the springs were collected and submitted to analysis by Professor F C Phillips of Pittsburgh They were all found to carry carbon dioxide, oxygen, hydrogen, and nitrogen but to vary greatly in relative amounts In general, those from Mammoth Hot Springs, where the waters issue through limestones, are characterized by carbon dioxide, one analysis from the spring upon the main terrace holding no less than 98 68 per cent of the gas Those from the upper basin, which issue directly from the rhyolite, consist principally of nitrogen, the Artemesia Geyser carrying 95 08 per cent of the latter gas Traces of methane were found in several waters Hydrogen sulphide was only detected in two samples, and in neither of these did the gas amount to one per cent of the gaseous content One of these was from a sulphur spring in the Mammoth Hot Spring Basin, and the other from the Shoshone Geyser Basin In none of the waters from the geysers and large hot

[5] Walter H Weed, "Formation of Travertine and Siliceous Sinter by the Vegetation of Hot Springs," U S Geol Survey, Ninth Ann Rept, Washington, 1890

[6] Dr C W Hayes, Bull U S Geol Survey, No 315, pp 215–223, 1906

springs in the three principal geyser basins was any hydrogen sulphide detected

Professor Phillips says

> There is, in fact, a curious gradation between analyses from No 1 and No 10, as regards the proportion of nitrogen and carbon dioxide Oxygen is present in all of them, and as ten of these gases contain combustible elements, hydrogen and methane, it is evident that the gas as it escapes from the spring has not been exposed to a high temperature

It is admitted by most authors that under certain conditions all these gases may be contained in surface waters I think it has been shown that under the peculiar conditions in which these waters occur, and their lack of uniformity of composition, they must be considered as absorbed by vadose waters

One of the most marked characteristics and one of geological significance is the frequent variation shown in temperature, flow, and salinity of the thermal waters where they issue from the rhyolite plateau The solvent power of water holding mineral matter in solution is, as is well known, far greater than that of pure water Now the downward percolating waters gather material from the disintegrated rhyolite soil and in some measure from the soluble salts previously brought up from below There is also a certain amount of carbon dioxide derived from the atmosphere It is a fair assumption, therefore, that in percolating downwards the waters carry with them to the water level below no inconsiderable amount of material

The ascending superheated waters, under pressure, exert a far greater influence The work done by these waters, and that which is still going on, is self-evident even to the most casual tourist It is shown by the broad areas and ridges of altered and bleached rhyolite Nowhere is this more in evidence than in the escarpments along the Grand Canyon of the Yellowstone, where the gorgeous coloring is due to the oxidation of the ferruginous minerals The potent influence of such waters under existing conditions can hardly be questioned They readily attack both the glassy groundmass and crystalline feldspars of the rhyolite, and when the metasomatic changes are complete they leave behind an impure kaolinized material mixed with quartz and held together by colloidal silica

DEVELOPMENT OF SPRINGS AND GEYSERS

The ascending waters, in their circuitous course, penetrate fresh seams and cracks in unaltered rock which slowly widen under the disintegrating influences of aqueous vapors Finally, the thermal waters, following these cracks, issue at the surface as hot springs and pools The early waters are usually acid in composition, and deposit ferric and aluminous salts Occasionally they set free sulphur, derived from the decomposition of hydrogen sulphide In time the openings through which they flow become broader, the waters themselves, free from hydrogen sulphide, become clearer and neutral, and at last issue as siliceous alkaline waters Underground reservoirs are excavated and become sources of hot springs, and, under favorable conditions, geysers The geyser itself is simply a stage in the development of geological processes In time geysers themselves become extinct New geysers break out and, given the essential physical conditions, may develop eruptions quite as fine as any in action at the present time Geologically speaking, the final stage of thermal activity is a hot spring The tendency of a geyser is to develop a hot surface pool If from such pools there is discharged a sufficient amount of overflow, and if from the surface of these geyser pools there is an ample dissipation of heat into the surrounding atmosphere, explosive

action may cease and the geyser, as such, may become extinct. It is frequently stated that some geyser has ceased to be active and that this indicates the slow dissipation of the original source of heat. This I believe to be an error. The change is simply due to a shifting of the channel of the ascending waters.

If, on the other hand, there should be marked climatic changes and arid conditions should set in over the park and adjoining mountains, in my opinion, thermal springs would become extinct. Should this happen it would be evident beyond all question that the waters were derived from vadose sources. Again, with the disintegration of lavas and the building up and enlargement of reservoirs, existing conditions of hydrostatic pressure would cease and the circulating waters, unable to rise, would distribute themselves laterally, in which case there might break out at the base of the rhyolite plateau calcic springs such as we now find and have already described.

In all probability the magnitude of a geyser is, in a measure, dependent upon the size of the underground reservoir or series of reservoirs, produced by the disintegration of lavas along channels of ascending waters. It has been demonstrated by self-registering thermometers that cool infiltrating waters may drain into partially erupted reservoirs after geyser eruption. This has been shown in the case of the Giantess Geyser. The question was once asked by an attendant at the hotel who had spent several summers in the park, why Old Faithful was more apt to be several minutes behind time in September than in July. I am not aware that such a condition was ever established, but if so, my reply would be that in the autumn the infiltration of surface waters is not as rapid as in early summer, hence a retarding of the eruption by several minutes.

It is probable that the Norris Geyser Basin, in its thermal development, is later than the Upper Geyser Basin. In the former are found the early and more acid conditions, the waters of the geysers are mainly neutral and form deposits of arsenical sulphides, alum, and ferric salts. These phenomena are for the most part absent in the Upper Geyser Basin, where the waters have reached a more advanced stage and possess a siliceous alkaline composition.

With the exception of arsenic and boron, which occur in minute quantities, all the elements brought to the surface in solution by the thermal waters of the park have been found in the rhyolite. In this connection it may be said, and it is generally accepted by those who have studied the region, that the mineral waters of Pfaeffers, in the Tyrol, have a vadose origin, and analyses show that both these elements are present.[7] Both these elements are found associated together in many thermal waters of Europe. Not only is it true that, with these exceptions, all the elements are accounted for in the rocks, but the proportion of the ingredients in the waters bears a remarkable relation to that of the elements in the rhyolite itself. Silica and the alkalies are the predominating elements. Even lithia, which is a feature of many siliceous lavas, has been quantitatively estimated in all these thermal waters. The water from Old Faithful yielded .0056 of a gram per kilogram of water, which, according to the theoretical composition, shows that lithium chloride forms 2.44 per cent. of the amount of material held in solution. The neighboring Giantess Geyser carried precisely the same amount of lithium chloride. The low percentage of iron, manganese, lime, and magnesia contained in the ascending waters is readily accounted for by the comparatively small

[7] M. De Launay, *Annales des Mines*, February, 1894.

quantities of these elements in the glassy rhyolite through which these waters pass.

The circulating ascending waters may, to some extent, be charged by foreign substances other than by superheated aqueous vapors. Nevertheless, in the park country the vadose ascending waters do not appear to have been greatly affected by any primitive, deep-seated waters or their contents. Even if foreign mineral matter were present, it does not follow that the material was not taken up originally by vadose waters.

In Iceland geological conditions are apparently quite different, and volcanic eruptions may be said, geologically speaking, to be still going on, in strong contrast to the Yellowstone Park, where such action ceased many thousand years ago. In Iceland the thermal waters are, in my opinion, mainly vadose, and their heat derived from sources not far below the surface.[8]

I agree with Dr. Rudolf Delkeskamp[9] that temperature, included gases, and salinity in many localities are not in themselves conclusive evidence of the source of thermal waters, and that far safer criteria for the determination of the primitive origin of waters are to be sought in uniformity of flow and chemical composition. What I wish to emphasize, however, is that the thermal waters of the Yellowstone National Park are characterized by frequent variations of temperature, progressive transitions in chemical composition, lack of uniformity in mode of occurrence, and shifting in points of discharge, in other words, they lack the essential characters of primitive waters derived from deep-seated sources.

RADIOACTIVITY OF THERMAL WATERS

Throughout this paper in the discussion of the geological relations of the thermal waters to the rhyolite eruptions laboratory investigations bearing upon the composition of the rocks, waters, sediments and gases have been utilized. In the discussion of the circulation of descending and ascending waters almost nothing has been said in relation to the source of heat which raised the temperature of these waters. This is in part due to the fact that the problems involved are in great measure distinct from those treated here and time does not permit of their consideration, and in part because I know little about the matter. My opinions are still open to conviction. With this avowal I may be allowed to add that I am reluctant to believe that the source of the heated waters is, geologically speaking, deep-seated or sub-crustal.

In this connection it might not be out of place to mention the investigations of Professor Herman Schlundt and R. B. Moore, on the radioactivity of the thermal waters of Yellowstone National Park, conducted under the auspices of the U. S. Geological Survey, and recently published.[10] They found the rhyolites, limestones, thermal waters, gases, and sediments to be radioactive. Specimens of rhyolite from widely separated localities in the park were examined. These authors say:

> These data certainly seem to indicate that the hydrothermal activity so manifest in the park is

[8] Since presenting this address I have received from Dr. Thorkell Thorkelsson, of Copenhagen, a copy of a suggestive paper on "The Hot Springs of Iceland" which confirms me in the opinion of the vadose origin of the Iceland thermal waters. Dr. Thorkell's paper appears as a recent publication forming one of the *Memoires de l'Académie Royale des Sciences et des Lettres de Danemark*, Copenhague, 1910.

[9] "Juvenile und vadose quellen," *Balneologischen Zeitung*, XVI., Jahrgang, No. 5, 1905.

[10] "The Radioactivity of the Thermal Waters of the Yellowstone National Park," U. S. Geol. Survey Bull., No. 395, 1909.

not connected with localized deposits of radium In the above calculations the question of heat lost by diffusion and other factors is not taken into consideration, but after allowing a generous margin for error we do not see how more than one per cent of the heat required for the hydrothermal action can be ascribed to the radium content of the rocks

Recently deposited travertine at the Mammoth Hot Springs, as well as that of the Main Terrace, and from the preglacial capping on Terrace Mountain, was subjected to similar tests The same authors say

The travertine of Terrace Mountain is overlain by glacial boulders Since its activity is only one per cent of the recent deposits its age is about 20,000 years, which would also be the approximate time that has elapsed since the glacial period in the park

Furthermore, a sample of the Jurassic limestone underlying the Mammoth Hot Springs proved to be more radioactive than the most active sedimentary rocks tested by that eminent authority, R J Strutt, of England It is noteworthy that the latter rocks referred to were specimens of the oolite formation from near the celebrated springs of Bath

Strutt has also pointed out that siliceous igneous rocks are more radioactive than basic lavas,[11] a highly significant observation when it is borne in mind that the rhyolite of the Yellowstone National Park stands preeminent as an acid, crystalline rock Iddings and Cross[12] have shown that allanite, in microscopic crystals, is widely but sparsely distributed in the siliceous igneous rocks of the Rocky Mountains, and has been detected in the rhyolite of Yellowstone National Park Now allanite is known to carry small quantities of thorium It is a coincidence worthy of note that thorium emanation was determined in several of the hot pools, it being first observed in this country in thermal waters in an obscure hot spring in Norris Basin I see no reason, however, to doubt the conclusions of Messrs Schlundt and Moore that the heat produced by radioactive emanations from the rocks and waters is wholly inadequate to meet the requirements It seems necessary, at least from our present knowledge, to look elsewhere for the source of the heat dissipated by the thermal waters of the Yellowstone Park

[11] R J Strutt, "On the Distribution of Radium in the Earth's Crust, and on the Earth's Internal Heat," *Proc Roy Soc*, Ser A, Vol LXXVII, 1906, p 479

[12] Jos P Iddings and Whitman Cross, *Am Jour Sci*, 3d ser, Vol 30, August, 1885, p 108

SUMMARY

In conclusion I may state that I have attempted to show (1) that igneous activity was continued throughout Tertiary time, (2) that this activity came to an end with the close of Pliocene time, (3) that during the Eocene and Miocene deep-seated waters were active geological agents, and that these waters were essentially primitive in their origin, (4) that in strong contrast to the explosive, volcanic conditions of the Miocene, the Pliocene lavas were emitted under far quieter conditions and built up the successive flows that formed the rhyolite plateau, (5) that during the many thousand years since the withdrawal of glacial ice, the Pliocene rhyolites have, since the beginning of Pleistocene time, been steadily undergoing progressive changes, brought about by the action of enormous volumes of superheated vadose waters, (6) that the gases contained in the thermal waters were in great measure derived from vadose sources, (7) that the eruptions and periodicity of geysers are phenomena due essentially to varying conditions of reservoirs and channels of superheated waters situated only short distances below the surface, (8) that the

phenomena, as seen to-day, represent a phase in the evolution of thermal springs

ARNOLD HAGUE

U S GEOLOGICAL SURVEY

HISTORIOMETRY AS AN EXACT SCIENCE

IN the issue of SCIENCE for November 19, 1909, under the title "A New Name for a New Science" I proposed the term historiometry for that class of researches in which the facts of history have been subjected to statistical treatment according to some method of measurement more or less objective or impersonal in its nature These researches have chiefly had in view the listing and grading of historical characters, either for the purpose of studying mental heredity or for the better appreciation of problems associated with the psychology of genius Researches of this type are capable of a far greater expansion and application than is generally supposed They can be applied to events as well as to individuals They can, by treating the vast store of human records which exist in books as material for the construction of an exact science, work towards the solution of a wide range of historical problems, such as the causes underlying the rise and fall of nations or other fundamental questions in history

Before anything can be done which shall give general satisfaction and agreement it will be necessary for this subdivision of science to justify itself, to measure its own shortcomings, to appreciate its own limitations, as well as to prove its own right to recognition of independent estate

If we are to fathom historical causation by objective methods it is obligatory first to prove that history itself, as we commonly find it in the printed records, is a sufficiently valid account of what actually happened Second, it is equally necessary to find proof that the objective methods correctly deal with these facts It might be supposed that the second proof awaits the first, but this is not necessarily so If the records themselves were very much at fault, so that the statements of historians were very far from ideal truth, or if the objective methods of collecting and analyzing these statements were subject to a large error (or if both these forces were in play) then it would be difficult to find wherein the trouble lay But if, on the contrary, it fortunately be that history as we find it is in its important statements a fair representation of the truth, and if the methods of historiometry which deal with these records are also sound, then it is not difficult to prove both propositions at the same time

I will give some instances to illustrate this, which show that such is the case for several types of historical records and for several methods of history measurement This could not be done did we not possess some third criterion, some third standard of comparison of a non-historical nature One such non-historical criterion is furnished by the known correlation ratios for resemblances between close blood relatives as determined in the anthropometric laboratory. These have been worked out and accurately measured for mental and moral traits, stature, head index and length of forearm I have shown in "Heredity in Royalty"[1] that if the members of royal families are graded by the adjectives applied to them by historians and encyclopædists and then the coefficients of resemblance are measured between the near of kin, who have been so graded, these coefficients (historiometric) substantially agree with the anthropometric Such would not be the case if historians perverted the truth greatly, or if for any other reason the truth were largely unattainable To make this clear it is only necessary to think what the result would be if history were merely "a pack of lies agreed upon" as the extreme view puts it We should then fail to properly pick out our true intellectual giants and runts The result would be nothing but confusion A whole series of errors would be distributed at random This would act like rain on waves and flatten down to a common level the real differences between the individuals The correlation measurements would fail and we should get no results comparable to those obtained from the delicate and ac-

[1] New York, Henry Holt, 1906

curate measurements of the anthropometric laboratory.

Furthermore, any weakness in the method of grading, any failure to properly classify the great men in the high grades and the degenerates in their proper grades would work in precisely the same direction to lower the correlation coefficients. The supposed errors of history and the difficulties of grading act as two united strains of tension to pull the coefficients down towards zero, which would be the coefficient for random distribution. If the coefficient can stand the strain without declining, then, roughly speaking, we may conclude both that the historical foundation is just and that the method of procedure is sound.

There are two other illustrations of method which I would like to summarize here. One of these series of tests is the trying out of a standard biographical dictionary (historical persons) against two lists of contemporaries (non-historical persons) and all three in terms of still another set of facts, namely birthplaces of distinguished Americans. The second series of tests concerns the relative fame of Euripides *versus* Sophocles, the encyclopædias having been used and then this compared with expert modern criticism and both with the opinions of the Athenians.

As concerns American history, one fact is very evident at the start: whatever be the method of grading as applied to Americans or whatever be the mental eminence graded, some states in the union, some sections of the country, have produced more eminence than others far beyond the expectation from their respective white populations. In this regard Massachusetts always leads, and Connecticut is always second, and certain southern states are always behind, and fail to render their expected quota. I have already pointed out[8] that the ratios seem orderly for a first approximation. That is, the higher the grade of the individuals the greater and greater becomes the proportion of those born in Massachusetts. This may be expressed as a ratio, ρ into the random expectation. Thus if there were no forces at work beyond chance distribution the ratios for all sections of the country would be expressed by unity, $\rho = 1$. If there be found twice as many persons born in a certain locality as one would expect from the population let it be expressed as $\rho = 2$, three times as many, $\rho = 3$, etc. These ratios are easily computed and can be expressed as fractions or with decimals. I have computed these ratios for the thirteen original states, but will present here only the statistics from Massachusetts and Virginia.

It will be seen in Table I. that Massachusetts has never failed to produce twice as many eminent men as the population would lead one to expect, and has for some ranks and types of achievement produced about four times the expectation. ρ ranges between 2.1 and 4.7. Virginia, on the contrary, has but rarely produced as many as might be expected from the large white population and the ratios in the same table are either below the expectation or not significantly above it. The other New England states (statistics not here given) have all done more than their share, but always less than Massachusetts. New York gives a trivial though constant excess above the expectation. From here southward the ratios drop off suddenly, so that New Jersey, Delaware, Pennsylvania, Maryland, North Carolina and Georgia have always furnished less than their share. For South Carolina the ratios again rise and exceed the expectation but only by the slightest measurable amount. North Carolina, of all the thirteen original states, has always had the worst record in the way of producing distinguished men, the ratios falling to about one quarter of what might be expected from the white population.

Regarding the tables for the two contrasted states, Massachusetts and Virginia, and following down through the columns marked "ratios, or number of times the random expectation according to the population at the approximate age of their birth," one sees first that the Massachusetts ratios run from 2.1 to 3.9 and the Virginia from 0.2 to 1.1. The higher Massachusetts ratios are associated

[8] "American Men of Science and the Question of Heredity," SCIENCE, N. S., Vol. XXX., No. 763, pp. 205–210, October 13, 1909.

with the lists of names in which the standards for admission to the lists are higher—that is, specially selected groups of the more eminent. Massachusetts also shows an extra merit when science or literature is alone considered, but this is merely an accentuation of some cause or causes which have enabled her to lead, no matter what type of success be the criterion.

There is also to be seen a probably significant gain in the ratios for Massachusetts from the census of 1790 to 1850. A further study of this special phenomenon might develop some interesting conclusions. The ratio also rises when only those in *Lippincott's* are considered who have received adjectives of praise. Nine tenths of the persons named in this dictionary are given a passing notice by the editors and nothing critical is said of their lives or their work beyond the barest record. About one tenth receive such adjectives of praise as "celebrated," "illustrious," "eminent," "famous," "noted," etc.

A priori we may suppose that these represent an extra superior group as compared with the other nine tenths. *A posteriori* the supposition is verified, because how else can be explained the rise in the ratio for Massachusetts from 2.8 to 3.8? If this "adjective method" did not select a superior group it would not raise the ratios, or in other words draw it further away from random hazard for which $\rho = 1$. The more accurately it seizes hold of the right persons and justly expresses real differences dependent upon natural causes the more it will raise this ratio. One can now see how it is possible in this way, and in similar ways, to actually test the validity of any method of selection. Its value depends, among other things, upon its ability to raise, or lower, a ratio in a proper degree, suitable to the case in hand, so that the ratios shall fit in, and harmonize with other ratios and other results.

If, for instance, the "space method," or the selecting the 234 men who have had the most space allotted to them in the dictionary, had not raised the Massachusetts ratio from 2.8 to any more than say 2.9 or 3.0 we might be justified in concluding that this method was inferior in accuracy to the "adjective method." As it turns out, it raises the ratio to 3.6. So one suspects that the "space method" is not quite as accurate as the "adjective method," since it does not raise the ratio as much though it deals with a smaller group. Of course one instance like this does not decide anything. I merely give it as an illustration of the ways in which historiometry may proceed.

I have also essayed a new method, namely selecting from *Lippincott's* a list composed of all those Americans whose biographies have been written and published in separate works. This constitutes a very small and presumably correspondingly select group, 129 in number. The ratio for Massachusetts is here seen to rise to 3.9, practically the maximum. It should of course do so if the method is sound and is successful in seizing hold of the right men. This may prove a very accurate, practical and rapid method of objectively listing great men in ancient or modern history, subject of course to such limitations and adjustments as special problems may require.

It can be seen that the general raising of the ratios is in no way dependent on the dictionary containing a large number of clergymen and writers. As a matter of fact, more than a third of the names are those of lawyers, bankers, merchants, politicians, government officials, soldiers, manufacturers and engineers. Here by narrowing the list from 1,266 to 232 and dealing with only a small group, we raise the ratio from 2.4 to 3. It might be supposed by some that a greater attention is shown Massachusetts by writers of books, biographies and histories because these writers live in the neighborhood. "Lippincott's Biographical Dictionary," however, is published in Philadelphia. Still it may be influenced by previous writings and earlier biographical dictionaries published in the neighborhood of Boston. If this is so to any appreciable extent then we should expect the ratio for Massachusetts to fall when present-day persons are graded by methods which have either nothing or little to do with historical traditions.

TABLE I

List of Names	Total in the List Born in U. S. A.	Number Born in Massachusetts	Number Born in Virginia	Ratios, or Number of Times the Random Expectation According to the Population at the Time of their Birth: Mass.	Virginia
Lippincott's "Biographical Dictionary," edition of 1895	3,227	711	231	$\rho = 2.8$	$\rho = .6$
Same dictionary					
Americans born A. D. 1785–A. D. 1794	302	75	22	$\rho = 2.1$	$\rho = .6$
Born A. D. 1795–A. D. 1804	370	79	25	$\rho = 2.2$	$\rho = .6$
Born A. D. 1805–A. D. 1814	464	96	23	$\rho = 2.6$	$\rho = .5$
Born A. D. 1815–A. D. 1824	513	97	33	$\rho = 2.9$	$\rho = .8$
Born A. D. 1825–A. D. 1834	363	74	19	$\rho = 3.6$	$\rho = .8$
Born A. D. 1835–A. D. 1854	343	58	15	$\rho = 3.5$	$\rho = .6$
Average of the above six lists	2,355	479	137	$\rho = 2.8$	$\rho = .65$
Same dictionary, Americans who have received any adjectives of praise	320	95	23	$\rho = 3.8$	$\rho = .6$
Same dictionary, Americans who have been allotted extra space (20 lines)	234	67	20	$\rho = 3.6$	$\rho = .8$
Same dictionary, Americans about whom books have been written	129	39	14	$\rho = 3.9$	$\rho = .9$
Same dictionary, practical types only. Bankers, merchants, lawyers, politicians, government officials, engineers, manufacturers, soldiers	1,266	235	143	$\rho = 3.4$	$\rho = 1.03$
Same dictionary, selected list of the greater among the practical types (Adjective, space and biographical method combined)	232	60	29	$\rho = 3.0$	$\rho = 1.1$
"Who's Who in America," edition 1908–09	14,227	1,650	493	$\rho = 2.6$	$\rho = .9$
"Who's Who in America," practical types only (initials A–C)	1,131	132	33	$\rho = 2.5$	$\rho = .8$
"Who's Who in America," lawyers, judges, congressmen, government officials (initials A–C)	580	60	23	$\rho = 2.2$	$\rho = .9$
"Who's Who in America," engineers, inventors, architects (A–C)	134	16	3	$\rho = 2.5$	$\rho = .5$
"Who's Who in America," army and navy (A–C)	170	18	5	$\rho = 2.5$	$\rho = .7$
"Who's Who in America," business men, financiers, railway officials, manufacturers (A–C)	247	38	2	$\rho = 3.2$	$\rho = .2$
"American Men of Science," 1906, all persons	about 4,000	436	not yet calculated	$\rho = 2.7$	
"American Men of Science," 1906, the leading thousand	867	134	14	$\rho = 3.4$	$\rho = .4$
"American Men of Science," 1910, the leading thousand	874	131	17	$\rho = 3.4$	$\rho = .5$
Hall of fame (list slightly extended as in SCIENCE, N. S., Vol. XXXII., No. 813, p. 158)	50	20	7	$\rho = 3.3$	$\rho = .9$

Two such methods of grading we fortunately possess in the compilations known as "Who's Who in America," and "American Men of Science." The ratios for Massachusetts do not fall. They dove-tail in with the ratios from *Lippincott's*. Hence we may conclude that the differentiations found in *Lippincott's* are not caused by unjust historical tradition and, furthermore, as far as one can see they are not in part caused by the same. "Who's Who in America" has been often used as an objective basis for sociological inquiries, but the criticism has been made that this book gives undue inclusion of authors and professors. I think this criticism is unjust. About forty per cent. of the whole fall under the more practical types enumerated in Table I. These I have considered separately as far as the initials A, B and C. They yield a ratio for Massachusetts of $\rho = 2.5$, which is very close to that for the whole book $\rho = 2.6$. The same for *Lippincott's* is $\rho = 2.4$, which is not in its exact theoretical position, as it should be higher than that drawn from "Who's Who in America." It will, of course, be appreciated that the clearing up of small disagreements like this requires further analysis and the computation of the probable errors.

The ratios from Virginia I present in this abstract merely as a general contrast to Massa-

chusetts I prefer to make further statistical inquiries before attempting to interpret their meaning

The third series of tests which illustrate the exactitude of historiometry are drawn from comparative studies of the fame of Euripides and Sophocles In SCIENCE, October 7, 1910, Mr C A Browne called attention to the fact that Sophocles received the first prize from the Athenians twenty times, and Euripides only four times, while since their deaths various writers from Plato to Emerson have referred to and quoted Euripides more than Sophocles Mr Browne also shows that both Curtius and Grote, and biographical dictionaries, and encyclopedias as well, allot more space to Euripides than they do to his elder rival This seems to indicate that the opinion of the Athenians has been reversed by posterity, but the real explanation I have found to be otherwise

TABLE II

AUTHORITIES	SOPHOCLES			EURIPIDES		
	Space Lines or Pages	Adjectives		Space Lines or Pages	Adjectives	
		Pro	Con		Pro	Con
Bergk, "Griechischer literaturgeschichte," 1894	110 pp	128	28	137 pp	100	64
Bernhardy	74 pp	71	23	116 pp	105	97
Croiset	57 pp	115	13	71 pp	132	57
von Christ	34 pp	46	3	40 pp	35	20
Curtius	200 ls	25	0	773 ls	36	20
Müller and Donaldson	25 pp	31	3	30 pp	17	14
R C Jebb	11 pp	16	0	16 pp	24	11
Gilbert Murray	19 pp	31	4	28 pp	15	6
Jevons	11 pp	14	0	13 pp	19	9
ENCYCLOPEDIAS						
Meyer's "Konvasations Lexikon"	109 ls	9	0	120 ls	8	2
Brockhaus' "Lexikon"	112 ls	6	0	161 ls	2	1
"La Grande Encyclopédie"	298 ls	27	1	178 ls	5	1
"Encyclopaedia Britannica," 1890	550 ls	22	0	995 ls	10	4
"New International Encyclopedia"	207 ls	10	2	181 ls	7	3
Lippincott's "Biographical Dictionary," 1892	52 ls	8	0	45 ls	6	0

It appears that the problem that Mr Browne proposes is a very delicate one These two great Greek dramatists stand in such an exalted position and so close to one another, both being near the extreme range of human genius, that probably not two hundred individuals who have ever lived have exceeded them in eminence[8] Therefore, compared with all men of all historical time, these two are almost merged in something like a point at the extreme end of a line It is like splitting and measuring the components of a binary star at a great distance It would be no discredit to any objective method of differentiation if it failed to give interpretable conclusions As it is, it turns out that the problem presented is just within the limits of historiometric discrimination so that the figures yield uniformity and repetition warranting real conclusions

I have extended Mr Browne's list and have found confirmation of the statement that more space is devoted to Euripides than to Sophocles This would leave the impression that Euripides is to-day frankly considered the greater of the two, which is not the impression that one gains by even a cursory reading of the printed matter so spaced Furthermore, I am informed by John Williams White, Professor of Greek, Emeritus in Harvard University, that for the last hundred years the general estimate of scholars has placed Sophocles above Euripides This is precisely the conclusion which is obtained from the extraordinary character of some of the terms and sentences of eulogism which one finds applied to Sophocles In these same authorities one never finds for Euripides anything like the following "There has hardly been any poet whose works can be compared with those of Sophocles for the universality and durability of their moral significance of all poets of antiquity Sophocles has penetrated most deeply into the recesses of the human heart" (Muller and Donaldson) "He renders tragedy a perfect work of ideal art" (R C. Jebb). Occasionally the direct comparison is

[8] Conf J McK Cattell, *The Popular Science Monthly*, February, 1903, p 359

made and then Euripides suffers, for instance, as when Gilbert Murray says

> No wonder Sophocles won four times as many prizes as Euripedes . . . Sophocles shows at times one high power which but few of the world's poets share with him . . . in the second Œdipus there is a certain depth of calm feeling unfettered by any movement of mere intellect, which at times makes the subtlest and boldest work of Euripides seem "young man's poetry" by comparison

It can be easily seen that this general impression can be checked up and is unfailingly expressed by each ratio of the adjectives of praise (pro) against those of dispraise (con) For every single authority consulted the answer is the same,—the proportionate ratio favors Sophocles[4]

The "space method" fails here to give a verdict agreeing with modern and ancient opinion probably for special reasons peculiar to the case More plays of Euripides are extant and there is more to be said in the way of adverse or qualifying criticism It is not to be denied that the interest in Euripides is and always has been, intense, perhaps greater than in Sophocles, but the position of the latter is more majestic and more sublime The lexicons alone would have given this conclusion in a few minutes reading All these facts, in connection with those taken from Lippincott's dictionary, indicate that the "adjective method" is a very delicate way of measuring small differences if for any reason it is desirable to do so

The questions here touched upon concern only the individuals, but I know from material as yet unpublished that the quantitative objective method can be applied to events as well as to persons If its validity for the study of individuals can be securely grounded, then its application to events will naturally follow and will be thereby the more easily and surely established

Space has permitted only a brief abstract, but I think that enough has been given to prove that researches of this nature furnish harmony and order, intertwine and mutually support each other, form an organic structure, and are entitled to recognition among the exact sciences It must be remembered that exactitude in science is a relative term Abstract mathematics may be exact, but no science of physical measurement is really exact Astronomy, which is usually thought of in this way, only gives an approach towards an ever-expanding ideal No two observers have ever quite agreed upon the latitude of the Greenwich observatory and the last transit of Venus was, if I remember rightly, in comparison with the computed prediction, some eleven seconds off All we ask is that the exactitude shall be sufficient for the practical needs of the problem in hand

I think it must be agreed that this first synthesis and coordination of isolated researches presents a very encouraging picture It indeed gives proof that a workable instrument has been obtained capable not only of dealing with questions as intricate as human nature and its attributes but actually at the same time demonstrating the essential validity of the historical data on which are based the percentile grades, ratios, correlations or other super-structure This latter conception is to me the most interesting side of the whole matter It has usually been impossible to scientifically refute those critics who claim that the so-called facts of history are so uncertain and subject to so great an error and prejudice that it is unsafe to build conclusions upon them by statistical methods They have not of course ever known that such was the case nor have they ever had any way of estimating how far the records of history, as they exist in standard works, encyclopedias and biographical dictionaries, actually deviate from the absolute truth It has been assumed, on the other hand, by those who have been engaged in grading historical characters, that the records represent a fair approximation towards the ideal truth The human record which we call history stands somewhere between two extremes, somewhere between the quagmire of complete falsehood and heights of perfect truth It is possible as we go on to appreciate, with closer and

[4] In this part of the work I have had the assistance of Mr A A Jenkins, of the Harvard Law School

closer accuracy, just what deviation from ideal truth any great set of historical records contains.

Such researches give promise of at last furnishing the long-sought correct method of penetrating the tangled and perplexing jungle known as philosophy of history. This domain of thought is to-day in poor esteem among those who, as historians of the modern school, seek in documentary sources to reconstruct the past around some central theme, some individual age or nation. No wonder these careful investigators have become disgusted with the *a priori* dogmatism, the partizan spirit, the free generalizations from half truths and the eternally conflicting conclusions. Historical philosophers, in their desire to explain everything at once, have been content to formulate theories and then pick from the totality of history, selected facts to support them. With methods highly subjective, and carrying a large personal equation they could not help but find exactly what they wished. The ways of inductive science may be slow at first, but even a small nucleus of collected and coordinated facts soon grows with astonishing rapidity, and every objectively established piece of work makes it, with accelerated speed that much easier to progress along lines of certainty and exactitude.

FREDERICK ADAMS WOODS
MASSACHUSETTS INSTITUTE
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SCIENTIFIC NOTES AND NEWS

LORD CURZON will succeed Major Leonard Darwin as president of the Royal Geographical Society.

THE Bessemer gold medal of the Iron and Steel Institute, London, will, this year, be awarded to Professor Henri Le Chatelier, the French metallurgist. The Andrew Carnegie gold medal for 1910 will be awarded to M. Félix Robin, of Paris.

A COMPLIMENTARY dinner was given on March 29 by former students of King's College Hospital to Sir David Ferrier, M.D., F.R.S., to congratulate him on receiving the honor of knighthood.

DR. LUCIUS L. HUBBARD has been appointed regent of the University of Michigan. He has been instructor in mineralogy at the State Mining School at Houghton, Mich., and was state geologist from 1893 to 1899.

MR. GEORGE HENRY LIVENS, B.A., has been elected to a fellowship at Jesus College, Cambridge. His subject is mathematics.

DR. EDNA CARTER, instructor in physics at Vassar College, has been awarded the Sarah Berliner research fellowship for women. She will continue her work in physics at Cambridge under Professor J. J. Thomson, and in the laboratory of Professor Wein, of Wurzburg, where she received her doctorate.

THE annual awards of the Royal Geographical Society are announced as follows: The two royal medals have been awarded, the Founder's to Colonel P. K. Kozloff, and the Patron's to Dr. J. Charcot. The Victoria Research Medal has been given to Captain H. G. Lyons, the Murchison Bequest to Dr. Wilfred Grenfell, the Gill Memorial to Captain G. E. Leachman (Royal Sussex Regiment), the Back Bequest to Dr. Arthur Neve, and the Cuthbert Peek Fund to Mr. R. L. Reid.

DR. H. F. MOORE, of the U. S. Bureau of Fisheries, has sailed for Rome where he will represent the Bureau at the fifth International Fishery Congress to be held May 26–31. Before returning he will visit the coast of Algiers for an examination of the sponge fisheries.

AN expedition under Mr. Homer B. Dill, of the State University of Iowa, has left San Francisco for Laysan Islands in order to study the bird life and bring back specimens for an extensive group to be placed in the museum.

PROFESSOR F. E. LLOYD, of the Alabama Polytechnic Institute, is planning a trip into the Arizona Desert this summer, in order to continue his botanical researches in desert plant life.

ACCORDING to the *Bulletin* of the American Mathematical Society, Professors E. R. Hedrick, of the University of Missouri, and J. I. Hutchinson, of Cornell University, have been

granted leave of absence during the second half of the present academic year, they will spend most of their time in Paris Professors E. J Wilczynski, of the University of Chicago, and C L. Bouton and J L Love, of Harvard University, are also spending the present half-year abroad on leaves of absence

PROFESSOR HAROLD B SMITH, director of the department of electrical engineering at the Worcester Polytechnic Institute, lectured before the Cornell branch of the American Institute of Electrical Engineers on March 31 His subject was "Some Engineering Developments of the Electric Field of Force"

ON April 5, 1911, the University of Pennsylvania Chapter of the Society of the Sigma Xi initiated sixty-eight new members Thirty-three of them are alumni of the university who graduated before the organization of the chapter and have since attained prominence in scientific work Eleven are members of the faculty and twenty-four are undergraduates The address to the initiates on "The Two Fields of Activity of the Learned Professions," was made by Professor I J Schwatt, president of the chapter, and the society was addressed by Professor Allen J Smith, dean of the medical department, on the subject, "Schools of Applied Science in Relation to the Graduate School"

MR HENRY A PURDIE, of Boston, one of the founders of the American Ornithologists' Union and long identified with the ornithology and botany of New England, died at the Massachusetts General Hospital on March 29 and was buried at Mt Auburn Cemetery, Cambridge, April 1

MR BERNARD AMEND, president of the firm of Eimer & Amend, and a former student of von Liebig, died in New York City on April 6, at the age of ninety years

ALPHONSE LOUIS PINART, a French traveler and philologist, died at Boulogne (Seine) on February 13, at the age of fifty-nine years

THE biological laboratory of the United States Bureau of Fisheries at Woods Hole, Mass., will open early in the coming June, for the twenty-seventh season since its establishment in the present quarters A limited number of research rooms and tables will, as usual, be placed at the disposal of those qualified to conduct investigations in the various branches of marine biology Applications should be sent at an early date either to the commissioner of fisheries, Washington, D C, or to the director of the laboratory, Woods Hole, Mass

THE twentieth session of the Marine Biological Laboratory of Stanford University will begin Wednesday, May 31, 1911 The regular course of instruction will continue six weeks, closing July 11 Investigators and students working without instruction may make arrangements to continue their work through the summer The laboratory will be under the general supervision of Professor F M McFarland, instructor in charge

THE Society of College Teachers of Education has entered into an agreement with the University Press of Chicago whereby the editorial management of the *School Review* will henceforth be under the control of an editorial committee elected by the society This editorial committee consists of Professor M V O'Shea, president of the society and chairman of the department of education, of the University of Wisconsin, Professor E O Holland, secretary of the society and professor of education in the University of Indiana, Professor William C Bagley, director of the school of education, University of Illinois, Professor Frederick E Bolton, director of the school of education, University of Iowa, and Professor Paul H Hanus, head of the department of education, Harvard University To this editorial committee representing the Society of College Teachers of Education has been added Professor Willard C Gore, Professor Frank N Freeman and Professor Franklin W Johnson, all of the faculty of the school of education of the University of Chicago Professor Gore has been elected by the committee managing editor of the *Review* As a result of this agreement, the *School Review* will become the organ of the Society of College Teachers of Education It is

planned to make it of service to all who are concerned in any way with secondary education in this country. It has been decided also to publish in connection with the *Review* a series of supplementary monographs dealing in a detailed and scientific way with problems of secondary education.

In the examination for resident engineer, Department of the New York State Engineer, the time for receiving applications has been extended to April 20, 1911, and the requirements for admission amended as given below. Resident engineer, Department of State Engineer and Surveyor, salary $2,400 to $3,000. Applicants must have at least five years' practical experience in civil engineering, three years of which must have been in responsible charge of work. Graduation from an engineering school of recognized standing will be accepted in lieu of one year of the five years' experience demanded. While candidates will not be assembled for a written examination, they may be summoned for an interview with the examiners. Subjects of examination and relative weights: Experience, education and personal qualifications, to be rated upon the candidates' detailed statements and upon answers to inquiries which the commission may direct to previous employers and others acquainted with their experience and qualifications and upon the oral examination, 1, two theses—a report upon some work of importance carried out under the charge of the candidate, and a discussion of some assigned topic relating to the problems to be handled in the construction of the barge canal, 1. The theses are to be written and submitted by the candidate in accordance with instructions to be issued by the commission, of which due notice will be sent to those who file applications. Non-residents will be admitted, subject to the provisions of civil service regulation X, that in case the eligible list contains the names of three or more citizen residents of New York state, they shall be preferred in certification over non-residents.

The summer field session for 1911 of the School of American Archeology of the Archeological Institute of America, will be held at El Rito de los Frijoles, near Santa Fé, New Mexico. Facilities will be given students to observe or to participate in the excavations, begun in 1908, and now in progress at Tyuonyi, near-by talus pueblos and cliff-dwellings. Excursions will be made to facilitate a study of botanical and other environmental conditions of the tribes dwelling in the vicinity. During August, lectures will be given on the distribution and culture of the tribes in the southwestern section of the United States, on the evolution of design as shown in ancient Pueblo art, on the native languages, and methods of recording them. A course will be given by Dr. Lewis B. Paton, formerly director of the American School in Jerusalem of the Archeological Institute of America, on "The Ancient Semites" to afford an opportunity of a comparative study of cultures developed in semi-arid regions in the eastern and in the western continents. Other lectures for comparative studies are being arranged for. The object of the annual summer field session of the School of American Archeology is to bring together persons interested in the study of anthropology, for first-hand investigation and discussion, and to give students the opportunity for field work needed to supplement university instruction. The attention of teachers and students engaged in the scientific study of education is also called to the advantages of this work. At the close of the session opportunity will be given to visit the pueblos of Taos and Acoma, and the government excavations among the cliff-dwellings in the Mesa Verde National Park, Colorado. For details of the summer session, address *Director of the School of American Archeology*, Santa Fé, New Mexico.

The sundry civil bill passed March 4, 1911, by the late congress provided for a reorganization and expansion of the Alaskan interests of the U. S. Bureau of Fisheries. A new division of the bureau is created, the Alaska Fisheries Service, to hold the affairs of the fur-seal, salmon and other fisheries, and of the fur-bearing animals. The latter field is an entirely new extension of federal super-

vision, under the act of April 21, 1910, vesting control in the hands of the secretary of commerce and labor The fur-seal and salmon fisheries have been for years under federal control, and are now taken out of the division of scientific inquiry, unifying under one head the whole Alaskan service The new division has a total personnel of 25 persons and an annual salary appropriation of $41,530 Of the personnel, eleven positions are new ones and consist of the chief an assistant chief, three clerks, one assistant salmon agent, one warden and four deputy wardens The increases apply mainly to the fur-bearing animals and the salmon fisheries, the fur-seal service having received in the year preceding additions to its personnel, made necessary by the expiration of the lease of the Pribilofs and the taking over by the government of the entire business of taking and selling seal-skins The chief of the Alaska Fisheries Service will be Dr Barton W Evermann, for eight years chief of the Division of Scientific Inquiry Dr H F Moore, for eight years principal scientific assistant in the Division of Scientific Inquiry, succeeds Dr Evermann as chief of that division Mr M C Marsh remains as chief Alaska salmon agent and Mr Walter I Lembkey as chief fur-seal agent

UNIVERSITY AND EDUCATIONAL NEWS

THROOP POLYTECHNIC INSTITUTE, Pasadena, Cal, has received for endowment four gifts aggregating a quarter of a million dollars. The largest is $150,000, there is one of $50,000, and there are two of $25,000 each The income becomes available after July 1, 1911

MR. JAMES A PATTEN has added $50,000 to the $200,000 which he had given to the Northwestern Medical School for the study of tuberculosis

A BUREAU of research in municipal government is to be established at Harvard University, to be maintained by a gift of $2,500 a year for ten years offered by Mr Frank Graham Thomson, of the class of 1897, and Mr Clarke Thomson, of the class of 1899, both of Philadelphia, Pa Professor W B Munro is to direct the work of the bureau In connection with this bureau material bearing on national and state government is to be collected, the work to be maintained by an anonymous gift of $1 000 a year for five years, Dr Arthur N Holcombe, instructor in government, is to be in charge

MISS MARY ANNE EWART has bequeathed £20,000 to Newnham College, Cambridge, for scholarships for women students and £10,000 to Somerville College, Oxford, for like purposes

NORTHWESTERN UNIVERSITY has arranged an architectural competition for the development of the university campus It is proposed to erect at once dormitories costing $150,000 and in the near future an academic building costing about $180,000

THE upper wall of the west tower of the William Rainey Harper Memorial Library, in course of construction at the University of Chicago, has fallen, demolishing the interior of the tower from top to bottom The loss, which falls on the contractors, is estimated at $50,000

PLANS for the first summer session of the Johns Hopkins University have been announced Work will begin on July 5 and will last six weeks

THE Nebraska legislature, reversing a previous vote, has permitted the University of Nebraska to apply for admission to the benefits of the Carnegie Foundation

BOWDOIN COLLEGE proposes to adopt a plan for admission to college similar to that of Harvard Students are required to present a record of their school studies and to pass an examination in four subjects only.

DR L H MURLIN, president of Baker University, has accepted the presidency of Boston University

MR WILLIAM J. DUPPERT, of the United States Forestry Service, has been appointed instructor in forestry at the University of Nebraska to take part of the work of the late Professor Frank J Phillips

MR. A. FRANKLIN SHULL, assistant in zoology in Columbia University, has been appointed acting assistant professor of zoology at the University of Michigan, to succeed Dr. A. S. Pearse, who has gone to the University of Manila.

MR. DUNHAM JACKSON, now studying at Gottingen on a Harvard traveling fellowship, has been appointed instructor in mathematics at Harvard University.

AT the Normal College, New York City, Charles T. Kirk, instructor, has been promoted to be assistant professor of geology, and Miss Emily O. Long, to be assistant professor of botany.

DISCUSSION AND CORRESPONDENCE

THE METHOD OF SCIENCE, A REPLY

A RECENT number of SCIENCE (January 27, 1911), has a forceful address by Dr. Minot on the "Method of Science." It is a new presentation of a topic fully discussed from the attitude of pre-evolutionary thought, but in such a manner and from such premises that its logic can not serve as a basis of present problems. I do not have the feeling of disrespect for the old thought that Dr. Minot seemingly has, but I agree with him that its principles and methods give little help in solving the problems science now faces. But at this point our differences begin, for in his restatement of principles, admirable as it is, he cuts the ground from under the social sciences by putting up standards that they can not meet. I do not think he meant to do this, yet the feeling he shows against the old philosophy warrants the inference that he would pass a similar judgment on the results of social science.

A new statement of the laws of thought is certainly needed. Early logic was devised by the theologians to prove the existence of supersensual units. As instruments for this end the so-called laws of thought are effective. But we need other rules to solve present problems. Not only is this so, but the methods of investigation have been so altered during the past fifty years as to create new problems. Accurate measurements are a new device. There were cases of accurate measurement before the present epoch, but they were not numerous enough to create a peculiar type of reasoning and thus to force a revision of the rules of logic.

The old division was between inductive and deductive logic. This controversy is now practically dead and in its place is arising one between inductions based on observation and those on experiment. Observations are generalizations under complex conditions, while experiment means isolation, simplicity of environment and accurate measurement. Workers in physical science distrust observations and demand in their place carefully verified results. This change is not a matter of theory, but due to practical situations faced by scientists in their various fields. The new medicine of which Dr. Minot is so good a representative gives an excellent illustration of the situation that forces him to attempt a reformulation of the laws of thought. The old practitioner was an observer; he diagnosed cases from symptoms. The new school experiments and measures. To say that science is exact measurement means practically to shut out the old physician who carried his knowledge in his head and whose office was not a chemical laboratory.

But if the laws of thought needed to shut diagnosis out of medicine are formulated as general laws, rules are set up that exclude all social judgments derived from observation. The tendency to do this is already visible in biologic sociology whose premises are taken bodily from biology. Bold deductions are made and conclusions drawn that sweep aside all generalizations based on observation. Here is a sample of reasoning of which we will have many more if Dr. Minot's rules of thinking win acceptance. I quote from a recent magazine article. "No generalization has ever exercised such a far-reaching effect on thought as the theory of natural selection. It is hardly necessary to point out that the corresponding belief in sociology is that all progress must come from the gifted individual, from the 'sport' who survives as the best of his kind. Darwinism lays stress not on the democratic

mass and their comfort, but on the few men of talent and their incomparable value to society" The essence of this position is the same as Dr Minot's[1] exact well-proven premises, a distrust of observation and the conviction that scientists seldom err except in their measurements This leads to long-range deductions and a neglect of verification within the field, where the conclusions are drawn

Such methods reflecting the growing tendency in science to disregard observation force those who use it to rise in its defence A controversy of this kind could not have arisen earlier because no one then questioned the validity of observation If, however, science has come to mean exact measurement and laws of thought are formulated in harmony with the new view, observation must also have its laws restated or its results will be questioned not in a few fields but in every part of scientific research.

When we seek to demark the field of observation from that of experiment, it will be seen that experiment is carried on under local specific conditions Only when an object is isolated and its environing conditions definitely fixed can the accurate measurements be made upon which the success of an experiment depends Observations, however, are made under complex conditions and usually they cover a large area of space or time The essence of an observation is to fix on some mark or characteristic of an object through which it may be recognized Reasoning through observation joins two such marks in the relation of cause and effect If "X" is always followed by "Y" the object of which "X" is a part is the cause of the object or event of which "Y" is a mark In observation wholes are thought of in terms of some of their definite marks and thus reasoning becomes a connecting of these marks in some casual relation In contrast to this procedure the "X" and the "Y" of an experiment are isolated from the wholes to which they ordinarily belong Then qualities and relations can thus be accurately measured and described

[1] I refer to such sentences as these "A broad examination of the method of science reduces itself to the study of the general principles of securing accuracy" "It must be doubted very seriously whether the study of logic is really essential for the right training of an investigator" "It is my belief that the logical work of scientific men is usually well done and is the part of their work which is the least faulty"

If this is the difference between observation and experiment, the mode of thinking used by the workers in the various sciences can also be contrasted There are four types of reasoning whose peculiarities depend upon the use made of observation and experiment The first group affirms that science is measurement and thus rules out observation This group of thinkers is of recent origin because the means of accurate measurement are a recent discovery It is no wonder that Dr Minot found books on logic useless for early logic gave rules for observation and deduction but did not recognize measurement as a means of investigation Now we have whole sciences within which measurement is the main source of progress whose workers are so effectively organized that observers of the older type are frowned down or excluded A social caste is thus formed who set up standards of their own and who issue a "Who is Who" of learned men from which they exclude those using observation as a method of research

The second method has become popular through the discussions of heredity that Dr Weismann began This assumes that if we have two series of events both measurable and certain the first is not only the cause but the sole cause of the second If, for example, there is a definite alteration of the hand it must have been caused by an antecedent modification of the germ cell of the organism All observations of the hand and all other sources of modification except those of germ-cells are shut out and a bold deduction is put in their place The method of this group thus includes nothing but measurement and bold unverifiable deductions They are playing havoc in the social sciences because their deductions become the basis of biologic sociology

If we pass from the sciences using experiment and measurement to the social sciences that depend on observation, we likewise find

two groups. The method of investigation correspondingly changes since social science can not readily get at causes by experiment but must begin with observation of results and work back towards causes by indirect methods. This method has lately been renamed pragmatism and involves a judgment of causes through their effects. Consequences are open to observation, causes are not. A cause must therefore be judged by its observed effects. The leading exponent of this method was the late Professor James. I do not wish to defend his arguments, but to call attention to his method. His observations—those on which truth depends—are psychic phenomena. We may therefore call this method psychic pragmatism, for the satisfaction that the perception of truth affords becomes its test. There is, however, another method that goes out from consequences just as Professor James does but which uses objective social tests instead of psychic tests. Social pragmatism uses marks to visualize wholes, but the marks are the objective social consequences of acts which can be measured and verified. Social consequences can be measured and through their observation a steady advance is possible in ways that will put social observation on a par with physical measurements as a means of developing science.

If it can be agreed upon that observation and experiment furnish the only basis upon which investigations can rest the next subject of importance is the canons of reasoning. Dr. Minot assumes that the reasoning of scientists is seldom defective and that their main errors are those of measurement. Scientists however, are as liable to errors of logic as other people and scientific method can not disregard the laws of thought. They are the very essence of good thinking and must therefore be formulated.

The first and primary rule is that only observations and experiments can be used as premises in deductions. This seems an innocent rule, but it involves more than at first sight is apparent. All experiments are local and specific in their conditions. There is no such thing as a general experiment and hence premises derived from them are local definite facts. The same is even more true of observations. They are made by individuals and no one can extend his observations over more than a local field. All valid data are therefore local and specific. Reasoning consists in extending the scope of these premises to other and broader fields. It follows from this that there is no difference in kind between an induction and a deduction. This distinction is due to the well-deserved disrepute into which the dogmatic assertions of theologians and metaphysicians fell. Scientists wanted therefore to get a peculiar mode of reasoning that would avoid these evils. In this they have failed. So many sciences have become deductive that the reasoning of scientists differ in no essential respect from that of any other group. The differences are in the premises and in the verifications, not in the reasoning. There is but one method of reasoning. Its rules apply to all thought and to all subjects. The same end that the distinction between inductive and deductive thought is attained by the second rule of good thinking. No generalization should be used as a premise in reasoning. A generalization is a result of previous thought and is only an approximate truth. Every new chain of reasoning must go back to the original data in the form of observations and experiments and be based on them together with the new data obtained since the original generalization was made. The chief violations of this rule are in social science, but scientists are not free from this error. They, like other people, form themselves into social groups and thus acquire dogmas and prejudices that induce them to use the generalizations of their group as premises when they should confine themselves to their data in the form of observations and experiments. Sound reasoning always goes from the local to the general. Universals are made either by some social group imputing value to a premise that serves their practical needs or they are loose generalizations based on imperfect data. Whatever their source, they are unsafe premises and lead to widespread popular errors.

From this it follows as a third canon of thought that all conclusions need an independent verification. If reasoning from generalizations were permissible and thought could legitimately move from an acknowledged universal to a particular, verifications would not be necessary. It is interesting to see the many ways in which thinkers try to avoid the need of verification. From this temptation scientists are no freer than other thinkers and they have furnished many notable examples of such errors. Verifications are, however, always necessary and they must be based on fresh data. Reasoning merely points out where these data exist and what data are pertinent. The work of getting at the truth is only half done when the conclusions drawn from premises are shown to be valid.

Thought is the connection between two objects or ideas brought about by the similarity or dissimilarity of their inherent elements. Progress in thought consists in passing from indefinite marks of this identity or difference to those capable of definite description and measurement. This fourth rule of good thinking brings out the relation between observation and measurement. Verifications are improved when observations are verified by experiment and experiment by observation. Only in this way can we be sure that the data of the verification are independent of those of the premises. There is a still further improvement when enunciated principles are based on observation and their verification consists of data arising from experiment and measurement. Such proofs are the most stable science can offer. It is a goal that can not always be reached, but it should always be striven for. Principles are most readily obtained from observation, their proof, however, is complete only when measurable data afford them a verification.

A final rule of thought is that no law is to be regarded general unless it is capable of independent statement and verification in many fields of investigation. This is the doctrine of multiple verification. It is often assumed that the way to prove a law is to get more data in some one field. Such a proof is less satisfactory than independent verifications coming from data derived from other sciences. It is the extension and restatements of a law in other fields and by independent investigators that raise its validity above local generalizations which have both time and space limitations. All observations and experiments are of this local character. They need multiple verifications to make them worthy of general acceptance. It is a corollary of this that thought is improved not by additional erudition in a given field, but by the movement of thinkers from field to field. There is a strong tendency to resent such a movement and the intruder is likely to receive rough treatment by his new colleagues. Yet this has been the way in which the greatest victories of thought are won. If Pasteur had not passed from chemistry to medicine his work might have been scientific, but it would not have been effective. Narrow specialization tends to such complete isolation of a group that its activity becomes socially valueless. The mobility of thinkers is the only safeguard against these evils. It makes trouble but it brings results.

Two conclusions follow from the preceding discussion. The first is that there is but one true method of reasoning in the use of which all are equally liable to error. The second is that there are two kinds of data, observations and experiments, both of which must form a part of any complete verification. These general statements would be of little use if they were not applied to the problems that separate social from physical science. While the opposition is general it is focused upon the controversies about man and his relations to the animal world. The one group use as their data the experimental knowledge of animals and then sweepingly apply this knowledge to man. "What is true of dogs is true of men" is a dictum coming from deductive medicine which illustrates the methods of all biologic sociologists. On the other side, there are social laws established by observation which have been accepted by the mass of mankind as rules of conduct. Which of these is right both in method and fact?

In the first place, it should be recognized

that men can not be put in laboratories and experimented on. It would seem, therefore, that observation must have a place in studies of man that it need not have in animal investigations. In the second place, the tests between the two methods do not lie in problems of normal development, but of pathology and degeneration. There are few observations about normality that are worth much. Social observations are mainly about defects and abnormalities. Keeping these facts in mind, the issue is clear. I will state it in the words of Dr. F. A. Woods: "Experimentally and statistically there is not a grain of proof that ordinarily environment can alter the salient mental and moral traits in any measurable degree from what they were predetermined to be through innate influences."[1] To test such a statement it must first be asked what are "mental and moral traits." If Dr. Woods means traits like sympathy, I agree with him. I know of no observational evidence showing it can be altered except by organic development. This may be true of all positive characters. But many so-called characters are not positive traits but merely conditions. We can not make good men better merely by an environmental change but we can in this way eliminate vice. Is there then a difference between a condition that leads to degeneration and a biologic trait that is necessary for progress? To be specific, are drunkenness, hysteria and criminal tendencies conditions having objective causes or are they biologic characters? Social observers point out what the conditions are that bring on these results and contend that the so-called traits appear and disappear with the presence or absence of given objective conditions. The deductive biologists start with premises about germ cells and apply their conclusions to man without verification. The difference is not one of fact, but of the sufficiency of bold reasoning.

If, as Dr. Minot asserts, scientists seldom err in conclusions when their measurements are exact the weight of authority is with theorists. I am not so sure of this as he is. The weakness seems to me to lie in the difference between the conditions of man's survival and those of lower animals. Before the rise of social sentiments elimination acted sharply against the defective individual, and hence degeneration could not become prominent. Then all traits were traits of survival and few pathological states appeared. Man, however, through sympathy preserves the weak and hence lowers the average man below his normal condition. If we regard one hundred points as the normal level in the animal world the lack of ten points would lead to elimination. In human society, however, a man could lack forty points and yet perpetuate his kind. I do not wish to attempt a mathematical demonstration, but it is plain that human sympathy reduces materially the sharpness of elimination. Sympathy could not act in this way if society did not have a surplus that it used to maintain the defectives. Sympathy is thus the indirect cause of the failure of elimination, but a condition of surplus is its direct cause. If it were absent, only normal people and normal traits would survive.

There are two objective conditions that reflect themselves in abnormal traits, a condition of surplus and a condition of deficit. The traits due to a surplus are usually called vices, while those of deficit are called crimes. These terms are not sharply contrasted, but their use is definite enough to illustrate my meaning. Give men more than they need and they sink into vice; take from them what they need and they become criminal. If vices and crimes can be changed or removed by altering income conditions we have proof that vicious and criminal traits are not biologic but economic in origin. We can then conclude that abnormal traits are not true biologic characters, but the impressment of economic conditions which are modified as the environment gives a surplus or deficit to those within it. A condition of deficit desocializes those who suffer from it and thus brings out atavistic traits not appearing in normal persons. A condition of surplus making people emotional, morbid and hysterical undermines the power of the will. Deficit people can be said to be

[1] *The Popular Science Monthly*, April, 1910.

too willful, while surplus people are almost will-less

I do not use this argument to show that my position is correct but to make clear what it is on which the contrasted arguments rest. The biologic sociologists are using bold deductive arguments without a verification. Their position has plausibility only by ignoring observational evidence. Deductive medicine with its neglect of diagnosis puts itself in the same position. The one group affirms that what is true of germ cells is true at maturity while the other says what is true of dogs holds for men. This is reasoning, not observation or experiment.

It is said of Agassiz that he took his students out to a great boulder near Cambridge and asked them what they saw on it. Some saw nothing; others saw vague scratches. Only he saw the ice-markings and proof that the boulder was deposited by a glacier. By the methods of to-day instead of these observations we would have exact measurements of the scratches; their depth and length would be carefully ascertained, and finally the Carnegie Institution would be asked to make a grant for weighing the stone. In this way note-books would be filled and a reputation made, but who will say all this is worth as much as what Agassiz saw with his unaided eye? Logic has pitfalls for all of us; we escape from our errors only by shrewd observations and multiple verifications.

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MIASTOR LARVÆ

THESE remarkably interesting larvæ, reproduced by pedogenesis, are available for laboratory work to a marked degree and must be widely distributed as well as allied forms. Very little is known concerning American species, largely because their habitat is one rarely explored by entomologists. They breed mostly in decaying vegetable matter. We have been very successful in finding them under partially decayed chestnut bark of stumps, fence rails and sleepers which have been cut one or two years earlier. European species have been observed under the bark of a variety of trees and even in sugar beet residue. These dipterous maggots with diverging antennæ have a flattened, triangular head quite different from the strongly convex, usually fuscous head of the *Sciara* larvæ occurring in a similar environment. They have a length of from one twentieth to one eighth of an inch and may be found in colonies containing a few large, white larvæ with numerous smaller, yellowish individuals, though the latter appear more common at the present time. Early spring with its abundance of moist bark appears to be the most favorable season for finding the larvæ. The writer would welcome the cooperation of entomologists and others in searching for these forms in different parts of the country. He will be pleased to determine specimens found under various conditions, make rearings therefrom if possible, and thus add to our knowledge of the subfamily Heteropezinæ, a group which should be fairly abundant in North America and one deserving careful study.

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SCIENTIFIC BOOKS

Minéralogie de la France et des ses colonies, description physique et chimiques des minéraux, étude des conditions géologiques de leurs gisements. Par A. LACROIX. Paris, Librairie Polytechnique, Baudry et Cie, éditeurs. 1893–1910. Four volumes. 8vo. Pp. xx + 723, 804, vi + 815, iii + 923.

This monumental work, which testifies at once to the untiring industry of the writer and to his thorough mastery of the material he has collected, is destined to rank as one of the most valuable contributions to the science of descriptive mineralogy. It consists of four large volumes, containing in all about 3,300 pages, and illustrated with more than a thousand figures, a large number of which are photographic reproductions of characteristic specimens. The first volume was issued in 1893, and at that time the author believed that the work would be completed in two years' time by the issue of a second volume,

but the material was so abundant that the issue of a third, and finally of a fourth volume became requisite.

In his preface to the first volume M. Lacroix calls attention to the fact that France has been commonly regarded as a land poor in minerals, and he finds an explanation of this belief in the comparatively slight favor that has been accorded to mineralogical studies there. A careful consideration of the geological features of that land, the great development attained there by the crystalline schists, by the ancient eruptive rocks, and by the later volcanic ones, should have served as proof that a great variety of mineral forms would be found. The author has sought in every case to trace the mineral to its original source and, as far as possible, to study the conditions controlling its production.

While it is essentially a treatise of descriptive mineralogy that M. Lacroix has produced, he has sought to give, in the case of each mineral, all the information necessary for the student regarding composition, optical properties and general characteristics, so that there might be no necessity to have recourse to other manuals. The crystallographic data are given both in the notation of Lévy-Des Cloizeaux and in that of Miller, and this greatly facilitates the use of the book for those unfamiliar with the French notation. The measurements given are all from specimens secured in the French deposits, the greater part of which have been collected by the author himself.

The considerable interval of time intervening between the issue of the second, third and fourth volumes, and the accumulation of new data—especially from Madagascar—that the author has collected during the past decade, renders the last volume a supplementary one, but the various new items are always referred to their proper place in the general scheme of the work.

The rich material has been arranged, in the main, according to the classification of Groth, and the full and accurate index renders it an easy matter to find the information given in regard to each mineral. The small percentage of mineral substances not included in the work are those which have not been found in France or in her colonies. The number of gem-stones—that is, of stones furnishing gem-material—is comparatively small, except in the case of the Madagascar deposits. Of the precious metals also there is no great abundance, in spite of the well-known fact that in Roman times the Gauls were exceptionally well supplied with gold. They appear to have nearly exhausted the deposits with which they were acquainted, and no new ones of equal value have since been discovered. In this connection, we may note (Vol. II., p. 422) an illustration figuring a gold medal struck in 1786, and made from the first ingot secured from the mine of La Gardette, dept. Isère.

The fourth volume is largely occupied with the treatment of the great variety of minerals found in the French colony of Madagascar, many of these having been collected by M. Lacroix in 1902 and 1903, when he was on an official mission to the island. More especially the pegmatite rocks of Mt. Bity and its neighborhood have yielded fine specimens of a great many types and varieties with which we are already familiar, and also some that are new or have not been met with in the same perfection elsewhere. Among these may be noted a new species, bityite, named by M. Lacroix, and the beautiful pink variety of beryl, which the writer of the present review has named morganite, in honor of our distinguished fellow-citizen, J. Pierpont Morgan. As the beginning of the systematic search for minerals in Madagascar is of such recent date, we may hope that the future has other pleasant surprises in store for us.

In the course of the publication of this work, begun eighteen years ago, the author was elected a member of the Académie des Sciences in Paris, an honor no one has better deserved than he. His single-hearted devotion to the progress of science is well shown in the following words prefixed to the last volume of his book: "I shall consider myself amply rewarded for my long task if this book should help to stimulate the study of the natural history of minerals in France."

It must be welcome news to the French that their recent acquisition, Madagascar, known as the "Grande Ile," contains many minerals valuable from a commercial point of view, and which may eventually serve to make some return to France for her immense expenditure of blood and treasure in establishing her dominion in that island Very possibly similar investigations systematically conducted in parts of Cochin China and Tonquin would also reveal mineral deposits of value, not yet uncovered

M Lacroix, who was born in Mâcon, department Saône-et-Loire, February 4, 1863, was a pupil of F Fouqué, of Des Cloizeaux and of Michel-Lévy, and has been since 1893 professor of mineralogy at the Muséum d'Histoire Naturelle, in Paris, an institution founded in 1793, during the French Revolution Here the minerals contained in the Cabinet du Jardin du Roi, the greater part of which had been collected by D'Angiviller for Buffon, represent the nucleus of what has since become a most extensive and representative collection

The following illustrious men have served as directors of the museum Daubenton, 1793-1800, Dolomieu, 1800–1802, Hauy, 1802–1822, Alex Brongniart, 1822–1847, Dufrenoy 1847–1857, Delafosse, 1857–1876, Des Cloizeaux, 1876–1893, Lacroix, 1893 to the present time

The important collections forming part of the great museum collection[1] are as follows Collection de Chantilly (1793), Coll Weiss (1802), Coll Brongniart (1823), Cabinet de la Monnaie (Coll Sage 1825), Coll Gillet de Laumont, embracing the collection of Romé de l'Isle (1835), Coll Hauy (1848), Coll de l'Académie des Sciences (1855), Coll Dusgate (1874), Coll Bischoffsheim (1890). All of these, except that of Hauy and of M Bischoffsheim, are in the general collection

Besides his "Minéralogie de la France," M Lacroix has published an exhaustive study of the intrusions in volcanic rocks, and, in collaboration with M. Michel-Lévy, a study of the minerals characteristic of different rocks[2] In addition to these special works, no less than 260 articles and papers issued in various scientific journals bear witness to the great industry and to the many-sidedness of this writer[3] There is no broader mineralogist in Europe, the range of his knowledge and the extent of his work in geology, petrography, chemistry and crystallography, and in the correlation of these sciences, constitute and prove a combination of gifts and acquirements rarely met with in one man

The various scientific missions with whose execution M Lacroix has been entrusted have led him to Great Britain, Scandinavia, Italy, Germany, Greece, Asia Minor and Madagascar, as well as to North America and the Antilles After the dreadful eruption of Mt Pelee, he was selected to head the scientific expedition to Martinique in 1902–3. These missions have afforded him exceptional opportunities for the study of the conditions under which mineral forms appear in many different parts of the world, of their associations and probable genesis The wide experience thus acquired has undoubtedly contributed much to the special excellence of M Lacroix's work in the field of mineralogy Full appreciation has been accorded to him both in his native land and in foreign countries He has twice been Lauréat de l'Institut, in 1892, and in 1903, and, as we have noted, was elected a member of the Académie des Sciences, section of mineralogy, in 1904

He is an honorary or corresponding member of scientific societies in London, St Petersburg, Vienna, Rome, Turin, Kristiania, etc, and is also an honorary member of our New York Academy of Sciences

Eighteen names has Professor Lacroix added to mineralogy They are as follows Fouqueite (1889, *Bull Soc Min*, XII, 330),

[1] "Collection de Minéralogie du Muséum d'Histoire Naturelle," Deuxième édition, Paris, 8vo, 1900, 112 pp, 1 pl

[2] "Les enclaves des roches volcaniques," Mâcon, 1893, 770 pp with 35 figures and 8 colored plates, 8vo "Les minéraux des roches," Paris, 1888, 334 pp, 8vo

[3] "Notes sur les Travaux Scientifiques de M A Lacroix, Prof de Minéralogie du Muséum d'Histoire Naturelle," Paris, 1903, 4–126 pp

michellevyte (1889, *Comptes Rendus*, CVIII, 1128, "Minér de la France," IV, 48), morinite (1891, *Bull Soc Min*, XIV, 187, "Minér de la France," IV, 539) pseudoboleite (1895), gonnardite (1896, "Minér de la France," II, 279), ktypeite (1898), picrocrichtonite (1900, "Minér de la France," III, 284), pseudochalcedonite (1900, "Minér de la France," III, 159), grandidierite (1902, "Minér de la France," IV, 670), giorgiosite (1905), georgiadesite (1907), palmierite (1907), plancheite (1908, "Minér de la France," IV, 757), villiaumite (1908, "Minér de la France," IV, 881), bityite (1908, "Minér de la France," IV, 673), metacristobalite (1909, "Minér de la France," III, 806)

GEORGE F KUNZ

BOTANICAL NOTES

TWO NEW BOTANICAL JOURNALS

WITHIN the past few months two new botanical journals have appeared in this country, asking for recognition and support by botanists

The first in point of time is the *American Fern Journal*, the first number of which appeared about the middle of last August It is now announced to be the "official organ of the American Fern Society," and its place of publication is Port Richmond, N Y It is to be "devoted to the general study of ferns," and is to appear quarterly The field of the new journal appears to be distinctly systematic in the old sense, and would seem to be intended to serve old-time collectors of ferns, and the private makers of fern herbaria While the *Fern Journal* does not cover exactly the field already occupied by the *Fern Bulletin*, published by W N Clute, the latter being much less technical, it must be confessed that they are rather too nearly alike, and one is led to wonder whether there is room in this country for two journals devoted to such a small group of plants as the ferns However, we may hope that after a period characterized by a "struggle for existence" there may be a "survival of the fittest" In the meantime let us keep up our subscriptions for both periodicals, hoping that the best that there is in each may be preserved in the "survival," which may be a "Journal-Bulletin"

The other journal—*Phytopathology*—is also an "official organ," having for this relation the American Phytopathological Society It "is designed primarily as a channel of publication for the phytopathological contributions of the members of the society" The principal editors are Professor L R Jones, of the University of Wisconsin, Dr C L Shear, of the U S Department of Agriculture, and Professor H H Whetzel, of Cornell University It is to appear bimonthly, and the subscription price is three dollars

It is clearly to be a strictly scientific journal of plant pathology, having no popular leanings whatever Its field has hitherto been wholly unoccupied, and there should be no question as to the support of the journal It should be found on every botanist's table, and should be accessible to all students of plant pathology

A PERIODICAL FOR MOSS STUDENTS

A NEW chapter is opened for *The Bryologist*, with the January, 1911, number it becomes the property of The Sullivant Moss Society, and its officers recently elected become the advisory board President, Dr Alexander W Evans, Yale University, vice-president, Miss Caroline Coventry Haynes, Highlands, N J, secretary, Mr N L T Nelson, Des Moines College, Des Moines, Ia; treasurer, Mrs Annie Morrill Smith, Brooklyn, N Y They have appointed Dr A. J Grout, as editor-in-chief, with associate editors as follows Dr George N Best, Rosemont, N J, Dr. A W Evans, New Haven, Conn, John M Holzinger, Winona, Minn, and Professor Lincoln W. Riddle, Wellesley College, Wellesley, Mass

The Sullivant Moss Society has held seven most successful public meetings in affiliation with the American Association for the Advancement of Science, and plans to hold the eighth in the same connection at Washington, D C, this coming December.

It will be noticed that the associate editors represent an eminent authority in the several

groups treated of in *The Bryologist*, namely, Dr. Best, the pleurocarpous mosses; Professor Holzinger, the acrocarpous mosses; Dr. Evans, the Hepaticae, and Professor Riddle, the lichens.

HOUGH'S LEAF-KEY TO THE TREES

MR. ROMEYN B. HOUGH has brought out a handy pocket manual which he calls a "Leaf Key to the Trees of the Northern States and Canada." The booklet is of such dimensions that it can be carried very easily in one's pocket, its dimensions being 4½ by 6 inches, and not over a quarter of an inch in thickness. In about thirty pages all of the common native trees from the Rocky Mountains eastward, and north of the latitude of North Carolina, are briefly characterized by means of keys which refer principally to their leaves. With this in hand the tyro ought to find no difficulty in finding the name of any native tree in the region named. It should be especially helpful to young foresters.

SHORT NOTES

A YEAR or so ago W. N. Clute brought out a little "Laboratory Botany" (Ginn) for use in high schools, which should have been noticed long ago. It has already commended itself to teachers as a most useful laboratory guide.

THE crown-gall of plants is discussed very fully and conclusively in Bulletin 213 of the Bureau of Plant Industry, of the United States Department of Agriculture. The authors, Erwin F. Smith, Nellie A. Brown and C. O. Townsend, find that *Bacterium tumefaciens* produces tumors upon many species of plants in widely separate parts of the natural system. Thus peach, apple, rose, quince, chestnut, grape, etc., when attacked by this organism develop the growths known by the name of "crown gall."

Parts III. and IV. of Oakes Ames's "Orchidaceae" continue to maintain the high standard set in the first and second parts. The books are not only of high scientific value to the botanist, but the printing and paper are superb, and when added to the wealth of artistic etchings constitute volumes that any artist might be glad to own. They form a notable addition to the literature of botany.

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SPECIAL ARTICLES

THE POISONOUS EFFECTS OF ALCOHOLIC BEVERAGES NOT PROPORTIONAL TO THEIR ALCOHOLIC CONTENTS

SUCH a vast amount of investigation and discussion has been centered on the liquor problem during the last few years that it seems almost presumptuous to attempt to add any new information to the subject or even to emphasize a point which has been previously recognized but not thoroughly appreciated.

In the report of the investigations made by the sub-committee of the committee of fifty to investigate the liquor problem, Abel[1] states "That more concentrated alcoholic liquors or spirits are, from a practical point of view, the most toxic of all alcoholic beverages. If whiskey or cognac were always to be diluted with water until the percentage of alcohol was brought down to ten per cent. they would be no more toxic than wine of the same strength."

These statements would lead one to infer that if the alcoholic content of all beverages was reduced to the same percentage the toxicity of each beverage would be the same. If true, such a conclusion would greatly simplify the method of determining the relative harmfulness of the many kinds of alcoholic beverages.

Numerous investigators have subjected various living organisms to the influence of pure ethyl alcohol diluted with water and also to beverages which contained varying amounts of it. In general they have obtained definite results showing that alcohol in appreciable quantities is always injurious to living matter.

It is recognized that some species of living organisms are more resistant to the influence of alcohol than others, and also that some individuals of the same species are more resistant than other individuals, but if many indi-

[1] "Physiological Aspects of the Liquor Problem," 1903. A report by the sub-committee of the Committee of Fifty to investigate the liquor problem, edited by John S. Billings, New York.

viduals of any species are subjected to the influence of alcohol it can be determined in general how great an amount of alcohol the species can endure

In some experiments with rotifers, *Hydatina senta,* to determine the effect of different external influences upon the parent and offspring, various alcoholic beverages have been used and have given very definite results as to their relative toxicity These experiments are not exhaustive nor complete, but it seems advisable to record them since they demonstrate very clearly that the toxic effect of some of the common alcoholic liquors is not proportional to the amount of alcohol contained in them

The rotifers are microscopic aquatic animals living in certain kinds of foul water In the laboratory such water was prepared by placing a small amount of horse manure in a two-quart jar of tap water This mixture was inoculated with various kinds of bacteria and also with very small flagellated protozoa In about thirty-six hours the jar was swarming with millions of the small protozoa A cubic centimeter of this water containing the protozoa was added to nine cubic centimeters of tap water and then adult rotifers were placed in this mixture They lived in it readily eating the protozoa and laying eggs which developed into mature offspring in about forty-eight hours

Varying amounts of each alcoholic beverage were added to this water in which the rotifers lived thus causing the toxicity of the whole solution to vary according to the amount of the alcoholic beverage present in the mixture As an indicator to the toxicity of the beverages thus diluted with the water in which the rotifers lived, two points were noted (1) the percentage of alcohol present in the diluted beverage at which the animals died within 10 30 minutes, (2) the highest percentage of alcohol present in the diluted beverage at which the females produced apparently normal young

The following tables give the details of the experiments and bring out clearly the fact that alcohol is not the only cause of the injurious effects produced by alcohol beverages

If two beverages which contain approximately the same amount of alcohol are compared the poisonous effects of each are sometimes nearly equal as is true of claret and white wine or Holland gin and brandy, but, in other cases, the poisonous effects may be very unequal, as is very clearly shown in the comparison of the second sample of cider and Ballentine's ale Here the alcoholic contents of each are nearly equivalent but the toxicity of the cider far surpasses that of the ale in both sets of experiments as recorded in Tables I and II

TABLE I

Showing the Highest Percentage of Alcohol in the Beverages at which the Rotifers Lived 10–30 Minutes

Beverages	Per Cent Alcohol by Volume in Original Sample	Per Cent Alcohol in Diluted Portion of Sample Used	Duration of Life of Rotifers	No of Individuals Used
Cider	7 5	0 2	25 minutes	10
Cider	6 23	0 4	22 40 "	30
Cider	8 8	0 4	30 "	10
Claret	11	0 4	30–45 "	50
Claret	9 25	0 5	20 "	20
Port wine	19 65	0 9	30 "	10
Port wine	22 6	1 5	30 "	40
White wine	11 5	0 6	30 "	10
Sherry	20 5	1 5	30 "	40
Sherry	19 25	1 5	30 "	30
Dark beer	5 8	2	30 "	10
Red star lager beer	3 75	2	20 "	10
Schlitz beer	5 35	2	20 "	10
Budweiser lager beer	4 9	2	20 "	10
Ballentine's ale	6 3	2	20–35 "	40
Ballentine's ale	6 3	2	20–35 "	40
Bass's pale ale	9 25	1	30 "	10
Bass's pale ale	8 5	1 5	15 "	10
Rye whiskey	46 4	10	10 "	20
Blend whiskey	44 5	10	60 "	20
Holland gin	49	10	35 "	20
Holland gin	52	10	35 "	20
French brandy	50 8	10	20 "	30
Cooking brandy	53 2	10	25 "	30
Absolute alcohol	99 5	10	45–60 "	50

Liquors which contain a high percentage of alcohol may be more toxic or may be less toxic than liquors containing a low percentage of alcohol Sherry and port wine which contain about twenty parts of alcohol are much more toxic than Schlitz's beer and Ballentine's ale,

both of which contain less than seven parts of alcohol. On the other hand, Holland gin, which contains approximately fifty parts of alcohol is much less toxic than any of the beers or wines which range in their contents from three to twenty-three parts of alcohol. Thus it seems that the total poisonous effects of alcoholic beverages are not entirely caused by alcohol but are due in part to other substances.

TABLE II

Showing the Highest Percentage of Alcohol in the Beverages at which Apparently Normal Young were Produced

Beverages	Per Cent Alcohol by Volume in Original Sample	Highest Per Cent Alcohol in Diluted Portion of Sample in which Young were Produced	No. of Females Producing Young
Cider	7.5	.065	10
Cider	6.23	0.1	30
Cider	8.8	0.1	5
Claret	11	0.3	26
Claret	9.25	0.3	6
Port wine	19.65	0.3	10
Port wine	22.6	0.2	15
White wine	11.5	0.1	10
Sherry	20.5	0.9	14
Sherry	19.25	0.9	10
Dark beer	5.8	1	5
Red star lager beer	3.75	0.6	6
Budweiser lager beer	4.9	0.3	20
Schlitz beer	5.35	1	10
Bass's pale ale	9.25	0.05	10
Bass's pale ale	8.5	0.06	10
Ballentine's ale	6.3	1	15
Ballentine's ale	6.3	1	15
Rye whiskey	46.4	2	10
Blend whiskey	44.5	2	10
Holland gin	49	2	20
Holland gin	52	2	20
French brandy	50.8	2	20
Cooking brandy	53.2	2	30
Absolute alcohol	99.5	3–4	50

In further support of this statement a few additional experiments of a somewhat different nature were made. A certain quantity of both claret and sherry were placed upon a steam radiator and allowed to evaporate. In both cases a residue remained. As soon as this residue was thoroughly dried distilled water was added until the original volume was restored. Then each solution was diluted in the same manner as the liquors which contained alcohol. Rotifers were placed in various dilutions of these solutions and the results compared with those obtained from the liquors containing alcohol.

TABLE III

Showing the Comparative Acute Toxicity of Claret and Sherry with and without Alcohol

Beverage	Alcohol in Diluted Portion of Beverage Used	Duration of Life of Rotifers	Alcoholless Liquor Diluted in same Proportion as the Alcoholic Liquor	Duration of Life of Rotifers	No. of Individuals used in each Experiment
Claret	1%	8–10 min	1%	30 min	40
Sherry	2%	15 min	2%	60 min	40

TABLE IV

Showing the Comparative Toxicity of Claret and Sherry with and without Alcohol in Dilutions of which Young Rotifers were Produced

Beverages	Highest Per Cent Alcohol in Diluted Liquor in which Young were Produced	Highest Per Cent Alcoholless Liquor in which Young were Produced Diluted in same Manner as the Alcoholic Liquor	No. of Individual used in each Experiment
Claret	0.3	0.7	25
Sherry	0.9	1.5	25

The acute toxicity of claret and sherry which have the alcohol removed is much less than in the cases where the alcohol is present. Even with the alcohol removed claret is much more toxic than the alcoholless sherry and each of them is more toxic than absolute alcohol. The same fact is shown in the experiments where young rotifers were produced as is indicated in Table IV.

If alcohol is the only toxic ingredient of claret and sherry neither of them ought to produce poisonous effects upon rotifers after the alcohol is removed. These experiments, however, show that these two liquors are very toxic even when they contain no alcohol.

Tables I. and II. show that the wines are strikingly more toxic than the same percentage of absolute alcohol. Chittenden[1] found that wines had a greater inhibitory action on salivary and pancreatic digestion than did a cor-

responding percentage of absolute alcohol This he states is due to their acid properties

Malt beverages, as ales and beers, he states, also have a retarding influence on salivary and pancreatic digestion due to their acidity but it is less marked than it is in the wines Both of the above tables show that some of the ales and beers are decidedly less toxic than the wines Some of them, however, were as poisonous as the wines in the experiments where young were produced, but in the 10–30 minutes experiment on acute toxicity only Bass's ale equaled the toxicity of any of the wines Its toxicity was the highest of all the malt beverages but it did not exceed the lowest toxicity of the wines

The distilled beverages, whiskey, gin and brandy, were conspicuously less poisonous in both sets of experiments than either the wines or malt beverages This is probably due to the fact that in the distilling process of their manufacture the volatile substances are separated from the non-volatile and perhaps toxic materials and are subsequently used in the making of the liquors These distilled liquors approached the point of toxicity of absolute alcohol which was the least poisonous of all the alcoholic solutions used Because of its purity it served as a control with which all the other beverages can be compared

In a comparison it is readily seen that the wines are the most toxic, the malt liquors stand second in point of toxicity, and lastly the distilled liquors are the least toxic of all the beverages and approach nearest to the toxicity of absolute alcohol.

The value of these experiments is to show again that in the three main kinds of alcoholic beverages there are other important toxic ingredients than ethyl alcohol and also to demonstrate that the various alcoholic liquors when reduced to the same percentage of alcohol differ widely in their point of toxicity

The results perhaps explain why different alcoholic beverages have such different effects upon the drunkard even though an equal intoxication is produced. It is generally recognized that brandy produces a certain type of drunkenness and that cider produces another type differing widely from the brandy type. Many of the other liquors also produce a particular type of drunkenness the characteristics of which are typical for each liquor These types of drunkenness are doubtless partly caused, at least, by the non-alcoholic ingredients in the liquors

D D Whitney

Wesleyan University,
Middletown, Conn,
February 28, 1911

BIOLOGICAL SOCIETY OF THE PACIFIC COAST

The first meeting of a new society for Pacific coast biologists was held on April 1 at Berkeley, California An afternoon meeting, at which papers were presented by President Jordan and Professor Zinsser, of Stanford University, and Professors Kofoid and Maxwell, of the University of California, was followed by a dinner at the Hotel Shattuck, and by participation, in the evening, in a joint general public meeting of the newly organized Pacific Coast Association of Scientific Societies At this meeting addresses were made by Presidents Wheeler and Jordan, of California and Stanford universities, Professor Kellogg, of Stanford University, and Mr George Dickie, marine engineer, of San Francisco

The Biological Society of the Pacific Coast begins with an active membership of seventy, representing California, Washington, Oregon, Arizona and Utah Three meetings will be held each college year, of which one will be known as the annual meeting and will be held in conjunction with the meetings of the various other societies composing the Pacific Coast Association of Scientific Societies The officers of the society for 1911–12 are Professor Vernon L Kellogg, president, Professor H B Torrey, secretary-treasurer, and Professor H J Maxwell, third member of the executive committee

SOCIETIES AND ACADEMIES

THE HELMINTHOLOGICAL SOCIETY OF WASHINGTON

The fourth regular meeting of the society was held at Dr Stiles's residence on February 9, 1911, Dr. Stiles acting as host and Dr. Pfender as chairman

Mr Foster presented a note on a nematode from the stomach of the pig. This form had been provisionally identified as *Spiroptera strongylina*,

but the location of the vulva in the anterior portion of the body indicates that it is a new species or else that the available descriptions of the European *S strongylina* are in error in describing the vulva as near the anus *Spiroptera strongylina* has been reported from Texas in 1892 by Francis, who states that this species is common there but that the identification is doubtful, and from Kansas in 1910 by Kaupp, who figures the vulva as posterior He may have so figured it as the result of an error of interpretation Specimens in the helminthological collection of the Bureau of Animal Industry were collected by Kilborne as early as 1884 These specimens show the vulva in the anterior portion of the body The European species is usually described as having a smooth mouth, though von Linstow notes six round papillæ The American species has two lips and six long papillæ There are other differences in the ratio of the length of the large and small spicules

The worm occurs half buried in the mucosa of the stomach and is therefore a dangerous parasite Von Ratz in 1897 reported an epizootic due to *Spiroptera strongylina*, in which a number of pigs were seriously affected and some killed The parasite caused sloughing of the gastric mucosa and it is probable that the American species does the same It is therefore of some economic importance

Associated with the American *Spiroptera* were specimens of *Physocephalus sexalatus*, recorded here for the first time from the United States This is also the first record of its occurrence in the domestic pig Former records are from the peccary and the wild boar

Dr Goldberger presented a note on some trematodes of fish The œsophagus presents a notable peculiarity It is ordinarily described as ending at the fork where the intestinal ceca begin In some forms there is said to be no œsophagus present This statement is due to a failure to take into account a structure that is a part of the ceca though it really belongs to the œsophagus This structure is limited posteriorly by a constriction or sphincter, and is really a forked œsophagus, extending from the pharynx to this constriction This structure he has noted in the genus *Arygia* and in *Leuceruthrus*

Dr Goldberger also presented a note on a trematode from a black snake In this trematode (*Styphlodora bascaniensis*) Laurer's canal does not go to the dorsum and open to the exterior, but ends in a globular swelling containing cells like vitelline cells and some other structures interpreted as spermatozoa The worm has a well developed sperm receptacle *Aspidogaster conchicola* has been described as having a similar form of Laurer's canal

In discussing Dr Goldberger's paper, Dr Stiles called attention to the fact that in 1894 he had stated in a paper on *Fasciola magna* that the egg shell was probably formed by the vitellogene glands rather than by the so called shell glands A paper by Goldschmidt in 1909 has given in detail the formation of the egg shell, his conclusions being somewhat similar to those of Stiles in 1894 Dr Ransom stated that he had come to the same conclusion regarding the shell gland of certain bird tapeworms He had thought that possibly the walls of the uterus were partly responsible for shell formation as shells were found only after the eggs had been in the uterus for some time

Mr Hall presented a paper entitled "The Need and Desirability of a Biological Survey of the Parasite Fauna of the United States" The amount of data relative to the occurrence, distribution, habits and importance of the animal parasites of the United States is very small There are few persons who collect material or contribute notes in this field of investigation The large amount of material in the government laboratories at Washington has been largely collected at Washington and at the slaughter houses at big packing centers, and in these cases there is often little data as to the localities where infections were acquired

As a preliminary to a biological survey of our parasite fauna, statements as to the occurrence and distribution of our more important parasites, so far as the occurrence and distribution is known, should be made Such a statement would furnish incentive for additional records, as it is easier to refer to such a record and add to it than to look through our present scattered records, many of which are not available to most persons Conversely, such a record would serve as a guide in looking for parasites As an illustration of the utility of such a survey, it may be noted that the preliminary work on the hookworm made it possible for physicians to add intelligently to the records, thus mapping out the infected areas Conversely, it led physicians to look for the hookworm in those states from which it was recorded or where the records indicated that it would be found, for such records indicate possibilities and probabilities in addition to showing known facts

Such records indicate foci of infection and awaken the interest of persons resident at such foci. They are essential in campaigns of eradication. A study of the distribution, habits and importance of some of our animal parasites may throw light on life histories by indicating a corresponding distribution of intermediate hosts or of other conditions requisite for the life cycle. This would permit of outlining more adequate means of prophylaxis, would make possible more intelligent estimates of the economic importance of our parasites, and would aid in guarding against indigenous and imported species. With such preliminary compilations of records as a nucleus, it should be possible in time to proceed to a real biological survey of our parasite fauna.

Dr. Ransom presented a note on the viability of nematode eggs and larvæ. In some species there is a great difference between the viability of eggs or newly hatched embryos and that of the full grown larvæ. The first two are quickly killed by low temperatures or drying, but the ensheathed larvæ can be frozen for some time, or frozen and thawed alternately without damage. Of two cultures of ensheathed larvæ, one of which was kept out of doors during the winter and the other indoors, the former was found in the better condition at the end of the winter. The probable explanation is that low temperature inhibits activity and in this way conserves the food supply stored up in the intestinal cells of the larvæ. The ensheathed larvæ can also be dried for some time and then revived by the addition of moisture.

Nematodirus filicollis develops to the ensheathed stage before hatching, a period of about a month being required for the development at a temperature of about 70° Fahrenheit, whereas under similar conditions the stomach worm (*Hæmonchus contortus*) hatches in about two days, and does not develop to the ensheathed stage until after hatching. The eggs of *Nematodirus* are much more resistant to low temperatures than those of the stomach worm. A temperature of 12° Fahrenheit was found to kill eggs of the stomach worm in seven to ten days, while eggs of *Nematodirus* were viable at the end of eight weeks after exposure to the same temperature. At 32° to 40°, eggs of the stomach worm were still alive at the end of eight weeks, but were dead after thirteen weeks. The eggs and embryos of *Strongyloides* do not resist drying. In this genus the embryos do not ensheath.

Dr. Stiles presented a note on the progress of the hookworm work in this country, and noted the finding by Stiles and Miller, on the basis of microscopic diagnosis, of cases of hookworm disease in Kentucky. He exhibited maps showing all the counties known to be infected.

MAURICE C. HALL,
Secretary

THE ANTHROPOLOGICAL SOCIETY OF WASHINGTON

THE 453d regular meeting of the society was held in the hall of the Public Library, March 28, 1911, 8:00 P.M., with Mr. George R. Stetson, vice-president of the society, in the chair.

Professor R. B. Dixon, of Harvard University, read a paper on "Polynesian Mythology." After a geographical survey of the islands of the Pacific, including Polynesia, Melanesia, Micronesia and Malasia, the speaker gave a delineation of the pantheon and a concise exposition of the theology entertained, with greater or lesser variations, by the different tribes of these islands. The gods are broadly divided into greater and lesser ones. In addition to these there are ancestral and totemic deities. The four great gods are Tane (dialectically, Kane), Tu (Ku), Tangaroa (Tanaloa) and Rongo (Lono, also Oro). The lesser gods are for the most part considered as their offspring. Of the four great gods Tane is the greatest. He is conceived as self-evolved, existing from eternity, the father of men, and is connected with the sky. He is supreme in the Hawaiian Islands and New Zealand, although he had there no temples and scarcely received any worship, while in Samoa and central Polynesia at large he is almost unknown. The same is the case with Rongo, the god of agriculture, and Tu, the god of war. On the other hand, Tangaroa, who forms a group by himself, enjoyed great honor in Samoa and the central portion of Polynesia, but was associated with darkness and evil in Hawaii and seems to be a late comer into Hawaii, imported from Tahiti or the Marquesas Islands. There are, as a rule, no images made of the great gods. The only representations made of them are stone pillars or wooden poles swathed in tappa or mats. The mythology of the other islands of the Pacific Ocean, as that of Melanesia, Micronesia, agrees in some portions with that of Hawaii and New Zealand, in others with that of Samoa and central Polynesia.

The paper was discussed and commented upon by many of those present.

I. M. CASANOWICZ,
Secretary

SCIENCE

FRIDAY, APRIL 21, 1911

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SOME FACTORS IN THE INSTITUTE'S SUCCESS[1]

IT is fifty years to-day since Governor Andrew signed the charter of the Massachusetts Institute of Technology There are many in the community who have watched the growth of this institute ever since The dean of those who have been intimately associated with its government is Mr William Endicott—a tireless worker in its interest He writes to express regret that he can not be with us to-day, on account of a recent family bereavement, and adds "It has been one of the greatest pleasures of my life to watch the Tech's triumphant progress from small beginnings to its present assured position as one of the leading scientific institutions of the world" In spite of (perhaps, because of), its youth, and in spite of (if not because of) its earlier struggles and difficulties, it is now absolutely in the front rank—a recognized leader in its chosen field, held in respect and honor everywhere Why this conspicuous success? It is a question that has often been discussed in the reports of commissioners and other distinguished visitors from abroad, and in the councils of educators at home Many are the explanations offered—the earnestness and devotion of the faculty, the spirit and energy of the students, the loyalty and organization of the alumni, the completeness of its equipment, the number and distinction of its instructors, the variety of its courses, the thoroughness with which the students'

[1] Address by the president of the Massachusetts Institute of Technology at opening of the Congress of Technology, April 10

knowledge and ability is tested, the practical character of the instruction, the close touch with industries, the power of adaptation and resources manifested by its graduates, and so forth. These are doubtless all contributory causes and are the causes that naturally suggest themselves to a student not specially versed in the history of the institute.

At this season, when we are celebrating the fiftieth anniversary of its chartering, it seems natural to lay somewhat more emphasis on historic causes.

The more one looks into the matter, the more is he impressed by the fact that although many enlightened men cooperated in launching the institute on its course, the enthusiasm and the guiding power were supplied by one man—Rogers. His choice of Boston as a suitable place for the new venture was made deliberately. Be it remembered that he was not a New Englander, that he was nearly sixty years of age when the institute was founded, and that until then he had spent the greater part of his active life in the southern states. To the serenity of outlook on human affairs that marks the scientist and the philosopher, he added an element of passion (perhaps derived from his Irish ancestors), when he touched the realm of education. Nowhere in the world is the supreme worth of children more thoroughly appreciated than in America; nowhere is the preparation for their future regarded more generally as one of the holy offices; nowhere in America is this sacred duty more clearly recognized and more anxiously discussed than in Boston. So Rogers placed the institute here, not because of the paucity of schools in this neighborhood, but because of their abundance; not because of their weakness, but because of their strength. This, he thought, should be good ground in which to sow fresh educational seed, and ere long his expectations were fully justified. Men of light and leading in the community gave hearty support to the new venture. Governor Banks favored state aid to the institute on the ground that such an institution would "keep the name of the commonwealth forever green in the memory of her children." His successor, Governor Andrew, who signed the institute's charter, was greatly interested, and did all that he could to help. "We ought," he said, "to start out on a broad gauge and inaugurate a great plan looking to the long future of the commonwealth." An imposing array of individuals and of societies petitioned the legislature to aid in forwarding the new scheme. Had Rogers chosen his location less wisely, he might easily have failed to enlist such support. The advantages of his chosen ground became still more apparent at the critical time when men had to be found to carry out the new ideas. He realized that this was the point where he was to gain victory or suffer defeat, and in spite of the exceptional difficulties presented, he soon succeeded in surrounding himself with the right men. The original faculty of ten professors formed a vigorous group, with great reserve of strength, physical as well as mental. They all lived to a ripe old age, and nearly all earned distinction in their own fields. Four of the men are still happily with us, including the professor of analytical chemistry, Charles W. Eliot, whose vigor is not perceptibly diminished after forty years of exacting toil in the presidency of Harvard.

It seems clear, then, that one important factor in the institute's success has been the place of its birth. And if the place was propitious, the time was in some respects peculiarly so. It was a period of upheaval, to be followed immediately by one of rapid forward movement. The charter was granted within a few days of

the breaking out of hostilities marking the beginning of the great war The national crisis, of course, turned men's thoughts away from science and from education About a fortnight after the granting of the charter, Rogers attended a meeting of the Thursday Evening Club, and was called upon to speak on some matter pertaining to science According to a newspaper report of the time "Professor Rogers very gracefully declined to discuss the topic proposed, but made instead a stirring appeal to the club in favor of providing a regiment of our brave volunteers with knapsacks" Such a time seemed peculiarly unpropitious for initiating a new educational movement, and no doubt the war checked the early growth of the institute very seriously. However, after a few years, the nation was ready to turn with undivided mind to the great problems of development, and the seed having been sown earlier in good ground, the institute sprang up rapidly and reaped the harvest of hope engendered by the settlement of the grave moral and political questions to which the war was due In the quieter field of human activity, the field of thought, the world was experiencing an equally great upheaval. Darwin's great book had just been published, with results of the first magnitude in shaping the lives on which the world of intellect was to move forward for the next half century Kirchhoff's idea of spectrum analysis was just opening a new era in physics and in astronomy Faraday was nearing the end of his great career, but his splendid discoveries had not yet borne fruit in the field of practise His work, however, was having its influence on the mind of Maxwell, the greatest of whose scientific achievements was announced in 1865, the year in which the institute actually began to work. The world was just entering on a period of remarkable activity in the practical applications of science The scientists were still struggling with the difficulties of cabling The Boston of those days was somewhat proud of its critical spirit and in 1859 a writer in the Boston *Courier* proved at great length that all the so-called messages through the Atlantic cables were fictitious, mere shams to save the stock for a time Edison, who was living in Boston in 1868, and whose son is an under-graduate at this institute to-day, was just beginning his wonderful career as an inventor. A few years later, one of the greatest marvels of scientific achievement, the electric transmission of speech, was to be demonstrated in this very city, indeed, in this very hall, by Alexander Graham Bell, through his invention of the telephone

At such a time, and in such a place, an institution devoted to science and its applications had at least an excellent chance of success. The institute would, however, never have achieved what it has, if other forces had not contributed to its success Some of these have been mentioned earlier, but there is one of the very first importance, rarely, I think, appreciated at its real value, to which special reference should be made *There has never been any uncertainty or indefiniteness as to what the institute is aiming at in its scheme of education* Every serious student of education is struck by the fact that so many schools and colleges drift around, apparently without compass or rudder, with no definite idea as to what port they are trying to reach, or how they should go to reach it Here, at any rate, is an institution that, *from the very outset*, has had very definite ideas on these matters, whether those ideas be right or wrong Most of these ideas are set forth in Rogers's "Object and Plan," which forms a charter of the institute not less valuable than that which Governor Andrew signed At the time of writing it, Rogers was no novice in education He

was not far short of sixty, and had taught and thought on educational problems since very early manhood. He had discussed some such project as that of the institute for twenty years at least, and his ideas thereon had gradually clarified and crystallized, as can be seen from the record of their development which is accessible to all.

Rogers has sometimes been charged with setting up a school in a spirit of antagonism to existing institutions. There is no ground for such a charge. He was too catholic in his tastes to fail to appreciate the good in others, and in advocating something new, he took the safe ground that there was room for difference in the field of education. He knew, as every educated man must know, that the fear of what is called *useful* knowledge, is exaggerated, and for the most part groundless. He knew, as others do to-day, that the oldest universities all began with a clear recognition of the bearing of their studies on definite callings, and he recognized clearly that it was not a merit but a defect of these schools that most of them had failed to keep pace with the changes in the character of human occupations that time had brought forth. He saw, as Lowell did, that "new times demand new manners and new men" and that new conditions demand new schools. For the guidance of the new school, he laid down a few simple, but far-reaching, principles, which have governed the institute ever since. The first of these is the *importance of being useful*. There is, of course, no necessary antithesis between the individual and the social end in education. However, the laying of the emphasis *is* important, and Rogers laid it unhesitatingly on efficiency in the service of society. In his first address to the students at this institute, he set forth the *value* and the *dignity* of the *practical* professions for which they were to prepare themselves. (Rogers, himself, be it remembered, was a pure scientist, President of the National Academy of Sciences, the friend of Darwin, Kelvin, Helmholtz, and the like.) In earlier discussions with his brother with reference to the plan of the institute, emphasis had been laid on "the value of science in its great modern applications to the practical arts of life, to human comfort, and health, and to social wealth and power." And so when the institute was actually founded the importance of science was kept steadily in view. He regarded the scientific habit of thought as specially valuable in practical affairs and consequently in education he laid greater stress on broad principles and their derivation than on details of fact, and he held that the *spirit* of science was more to be desired than all the gold of scientific knowledge. These are his words: "In the features of the plan here sketched, it will be apparent that the education that we seek to provide, although eminently practical in its aims, has no affinity with that instruction in mere empirical routine which has sometimes been vaunted as the proper education for those who are to engage in industries. We believe, on the contrary, that the most truly practical education, even in an industrial point of view, is one founded on a thorough knowledge of scientific laws and principles, and one which unites with habits of close observation and exact reasoning, a *large general cultivation*. We believe that the highest grade of scientific culture would not be too high as a preparation for the labors of the manufacturer." It will be seen from this that Rogers made no fetish of science, and that he welcomed every really liberal study. Some of the champions of the new school joined in the attack on the older learning, but Rogers had no sympathy with such views. "The recent discussions here and elsewhere," he said, "on the relative value of scientific and classical cul-

ture seem to threaten an antagonism which has no proper foundation in experience or philosophy" And although the study of the classics has never formed part of the institute's courses, history, economics, languages and literature enter into its curricula far more extensively than is generally supposed

Apart from his appreciation of the value of all sound learning, Rogers saw clearly that the whole controversy as to the relative merits of science and the classics in the field of education missed the mark by placing the emphasis in the wrong place He understood that when one gets to the root of things in education, the *method* rather than the *subject* is of supreme importance, and his insistence on the value of method in teaching was the cardinal doctrine in his creed and the one that has contributed most to the success of the institute Doubtless his knowledge of the history of science turned his thoughts in this direction He must have pondered over the question, as every serious student has done, why throughout the ages the world stood so still in the realm of science It was not for lack of intellectual power, for no one who has examined the matter can fail to recognize that there really were giants of old The failure came through attacking the problems by the wrong method And Rogers concluded that much of the failure in education was due to similar causes What method, then, is the right one? His fundamental idea here was not original with Rogers It has been clearly expressed before, but rarely, if ever, adopted definitely as the basis of educational method and applied systematically throughout The idea is familiar to us all to-day, the idea of *learning by doing* "How can a man learn to know himself?" asked Goethe "Never by thinking, but by doing" Add to this the doctrine of Carlyle that "the end of man is an action and not a thought, though it were the noblest," and you have the whole thing in a nutshell Carlyle is often quoted as having said that the modern university is a great library He would have been truer to his own doctrine if he had said that the modern university is a great laboratory "The institute," General Walker was fond of saying, "is a place not for boys to play but for men to work" Boys and men alike learn most effectively by working for themselves, and the *do-it-yourself* method has been, I believe, the greatest factor in the success of this institute of technology

Whatever be the explanation, there can be no doubt about the fact of its success It is not merely that the institute is now the largest institution of its kind in this country, and as regards the extent and variety of its courses and equipment, the most nearly complete in the world It is not merely that it has grown so that there are a hundred students to-day for every one that took the preliminary course scarcely fifty years ago, and that amongst these students there are men drawn by its reputation from the greatest universities of England, France and Germany, as well as from the leading schools and colleges throughout this union It is not merely that its teaching staff has expanded so that it contains to-day more than two hundred and fifty men, and that amongst its hundred professors are to be found many men of prominence, and not a few of national and indeed international reputation It is not merely that amongst its graduates, there are men of the front rank as pioneers of knowledge in the field of pure science, nor that its ten thousand alumni have played so great a part in the development of the nation's industry and commerce, and in the preservation of the public health The most striking fact, when one

considers the institute's youth, is the fact emphasized on an earlier anniversary by Mr Augustus Lowell and expressed by him in the phrase, "The M I T is *pre-eminently a leader in education*" Its educational ideals and methods have been studied and almost everywhere the trend to-day is in the direction in which the institute has long been moving

To celebrate the fiftieth anniversary of the granting of the institute's charter a congress of technology has been arranged At this congress, which opens to-day, and will be in full activity to-morrow, prominent alumni and members of the faculty are to deal with problems raised in the field of their own specialty The guiding idea throughout is the gain in efficiency that comes from the application of scientific methods to the treatment of the great practical problems of the day The business world must be weary of amateur suggestions for the conduct of its affairs and there is danger of damage to a great cause by too much talk The problem of increased efficiency is no new problem to the man of affairs, and there is much that is thrust upon him in these days that he must have known for years On the other hand, a sane and serious discussion by men who know their subject and speak from experience must always be welcome, and doubtless in the proceedings of this congress there will be much of interest to the business men who are alive to the necessity of advancement and who are on the alert for suggestions that may be helpful in their own affairs

A glance at the program will give some idea of the variety of the interests represented, but more thorough study is needed to realize in any adequate measure that the work of this institute touches practical life at a thousand points What the institute has achieved in half a century has fully justified Rogers's statements when making his first appeal for public support "I am sure," he said, "that I speak from no impulse of mere enthusiasm when I say that this new undertaking presents an opportunity of practical beneficence in connection with education which is not only peculiar, but without precedent in this country My experience as a teacher and my reflections on the needs and means of industrial instruction assure me that this enterprise, when fully understood, must command the liberal sympathy of those who aim to make their generosity fruitful in substantial and enduring public good"

R C MACLAURIN

HENRY PICKERING BOWDITCH

DR BOWDITCH was one of the foremost leaders in the scientific development of America In the establishment of university laboratories for research he was a pioneer and for forty years he exerted a wide and profound influence upon the progress of physiology, of medical science and of university education It was the man himself which counted, for upon every one his sincerity, his absolute single-mindedness, his intellectual power and his genial spirit made a lasting impression, and created confidence in himself

Bowditch was born April 4, 1840, at Boston He descended from the best New England stock. Nathaniel Bowditch, the mathematician, well known to all navigators, was his grandfather His father was a successful business man, who bought a large estate at Jamaica Plain, upon a beautiful hill, which has a commanding view both of Boston and of the country for many miles around This hill is intimately associated with Dr Bowditch in the thought of all who knew him, for he continued as one of a large family colony to dwell on it until his death

He entered Harvard College, graduated in 1861, and entered the Lawrence Scientific School, but in November of that year he volunteered and became a second lieutenant in

the First Massachusetts Cavalry His regiment went south in January, 1862, and from that time until the close of the civil war he was almost continually in active service He resigned June 3, 1865, being then major of the Fifth Massachusetts Cavalry He reentered the scientific school, and passed from there to the Harvard Medical School, from which he received the degree of M D in 1868 He frequently referred with gratitude to the influence of Jeffries Wyman upon his own scientific development

With the approval and encouragement of his father he decided to devote himself to a scientific career, and as it was impossible to obtain satisfactory training in medical science at that time in this country, he went to Europe to study in Paris, Bonn and Leipzig At the latter place he worked under Carl Ludwig, of whom he always spoke with reverence and affection The great master found an apt pupil in the young American, and the pupil rapidly became a master himself Bowditch had remarkable mechanical talents Ludwig was wont to tell how Bowditch arrived in the laboratory when the kymographion invented by Ludwig was beginning to be used, and the automatic record showed only the movement of the muscle or heart, the time of stimulation being marked by hand Bowditch immediately set to work and produced the devices for recording the actual time and the duration of the stimulus automatically Many valuable ideas are simple, like Bowditch's invention, and after they have been produced appear obvious and invaluable, but in reality lucid simplicity is one of the essential characteristics of a superior intellect Bowditch was endowed with this quality in a high degree, and it showed itself throughout his life in the perfection with which he worked out the problems he had to deal with In Ludwig's laboratory he carried through his researches on the heart, which were of fundamental importance and therefore rank among the cherished classics of physiology

He remained abroad until 1871, returning to Boston in September of that year to become assistant professor of physiology at the Harvard Medical School Up to 1871 Dr Oliver Wendell Holmes had lectured on anatomy and physiology, thereafter the professorship was divided Holmes restricted himself to anatomy Physiology was assigned to Bowditch In 1876 he was made full professor In 1906 he resigned his position owing to failing health, and was made professor emeritus He met the increasing limitations of his illness with perfect courage Courage was one factor of his power over others Death came quietly on March thirteenth last

The Harvard Physiological Laboratory was the first modern laboratory for instruction and research in the medical sciences to be founded in America It was wonderfully equipped for the period of its foundation, for Bowditch put into the laboratory the large supply of apparatus, his personal property, which he had brought back from Europe He at once began a course of lectures in physiology, which excelled so enormously anything which had ever been presented in America, that the effect was instantaneous The consequences were revolutionary, for his work at Harvard initiated the creation of the new medical standards The present writer was his first research pupil and recalls vividly the revelation opened by admission to the new laboratory

During thirty-five years Bowditch was an efficient leader in the development of the Harvard Medical School, in the advancement of physiology and other medical sciences in the United States, and he found time besides to promote energetically many causes of civic betterment Very few men have contributed so much as he to the elevation of medical education He stood for the highest ideals of progress and maintained always that the old-fashioned "practical" physicians must be replaced by men scientifically trained and animated by the scientific spirit For this principle he carried on a long campaign In the face of opposition and much early discouragement he kept steadily at this great task, and had the satisfaction in the end of seeing his cause triumphant The superiority of the laboratories abroad, especially in Germany a generation since, made a profound impression

on American students. Bowditch was one of a group of young physicians who strove successfully to found at Harvard laboratories modelled on those of Germany. The result of their efforts was the medical school building on Boylston Street, which, when it was dedicated in 1883 was easily the best for its purposes in America. From the time of the opening of this building until 1893 Bowditch acted as dean of the medical school, and during this period the school improved with unparalleled rapidity largely owing to his personal influence. He was a man who had visions of better conditions, and worked to make them realities. It was his vision which first conceived a second new medical school on a magnificent scale of equipment, and it was mainly by his persuasion that the Harvard authorities agreed to attempt to carry out the plan. He threw himself with characteristic ardor into the work. Together with Dr. John Collins Warren and others he labored, and the magnificent laboratories, opened in 1906, which the school now possesses, commemorate his devotion and success. With the completion of the cluster of five hospitals at present under actual construction or soon to be begun, which will surround the laboratories, Bowditch's dream will be fulfilled. Fortunately he lived to know that this fulfilment was assured, though he could not see it completed.

Outside causes, sometimes professional, sometimes civic, often appealed to him. Thus he was one of the principal founders of the American Physiological Society, to the affairs of which, as of the National Academy and other scientific associations, including the International Physiological Triennial Congresses, he gave of his time generously and always helpfully. With a small group of colleagues in Boston he took up psychical research, and aided in founding and for several years in managing the American society. His open-mindedness was shown in this matter and was characteristic, but his experience finally rendered him extremely skeptical as to the reality of telepathy and other alleged psychical phenomena. He was a trustee of the Elizabeth Thompson Science Fund from its foundation in 1886 until 1906. Much of the credit of the success of that fund belongs to him. In Boston he served several years on the school committee, and also as a trustee of the Public Library. Whatever he undertook he tried to do well and with such complete singleness of purpose that every one with whom he was thrown in contact instinctively trusted him.

The manifold activities, which have been referred to, encroached upon his time, and in later years he occasionally asked a friend whether his life would not have been of greater service, if he had devoted himself exclusively to experimental physiology. His success in more extended research would have been great, for in all his actual researches he was eminently successful. Thus, his work on the growth of children remains still the best on the subject. His investigations on the indefatigability of nerves, on the knee-jerk, on ciliary motion and other subjects are important and are also models both of thoroughness of experimentation and of clearness of presentation. Nevertheless, one must reply to Bowditch's own question that his life was well and wisely spent, as measured by the value of his services to the general welfare. In view of his great efficiency in promoting not only physiology but science in general and in elevating medical teaching, we must admire with grateful appreciation his career, which has been a powerful factor in the advance of research and education in America.

His own researches only partially indicate his range and efficiency as an investigator, to measure which fully one must know the work of William James, Stanley Hall, Southard, Lombard, Porter, Cannon and many others, who worked in his laboratory.

He received many tokens, both personal and official, of the high esteem in which he was held. He was an honorary member of numerous scientific bodies, and received honorary degrees from Edinburgh, Cambridge (England), Toronto, the University of Pennsylvania and his own Harvard.

Dr. Bowditch married Miss Knauth in 1871. She was the daughter of a Leipzig banker,

whose house was the center of delightful hospitality to many Americans, studying at Leipzig. He found great happiness in his home life, in his children and grandchildren, and also in the numerous friends, whom he attached not only by his unusual abilities but by his personal charm. He was social by nature, keenly humorous, warm and faithful in his attachments, full of the zest of life. He was profoundly modest and seemed never to know how high his abilites were estimated by others. He never quarrelled, but was for every good cause he championed a good fighter. Perhaps his most distinguishing trait was his remarkable combination of keen practical sense in the use of means with enthusiasm in the pursuit of ideal aims. With all his buoyant vitality, with all his eager interest in men and affairs, he was essentially an idealist, who won the love and admiration of many friends both in Europe and America.

C. S. Minot

SAMUEL FRANKLIN EMMONS

The death of Samuel Franklin Emmons at his home in Washington, D. C., on March 28, 1911, after an illness lasting only five days, removed from the ranks of American economic geologists the one who, by virtue of his influence on the progress of his branch of science and by his long and illustrious service, worthily stood at their head. For the last few years Mr. Emmons's increasing infirmity had given concern to his friends, but his own cheerfulness and serenity were unaffected by bodily weakness and when his colleagues missed him from his desk at the Geological Survey offices during the few days before his death they believed merely that a cold in conjunction with unseasonable weather confined him to his house. None foreboded the fatal ending of his illness.

Born on March 29, 1841, in Boston, Mass., the home of his ancestors since 1640, Mr. Emmons at his death lacked one day of his seventieth year. His great-grandfather, Samuel Franklin, after whom he was named, was a first cousin and close friend of Benjamin Franklin.

Mr. Emmons graduated from Harvard College in 1861 and went abroad to continue his studies, first at the Ecole Impériale des Mines in Paris and afterwards at the Bergakademie in Freiberg, Saxony. He returned to the United States in 1866 and after spending eight months in visiting the mining districts of the west he joined Clarence King as a volunteer assistant in the United States Geological Exploration of the fortieth parallel, receiving his official appointment in the winter of 1867-8. For nearly ten years he remained with this organization, seeing varied service, gaining that wide knowledge of the geology of the west that he afterwards turned to such good use, and contributing to the published results of the exploration. With Mr. Arnold Hague he was joint author of the second volume of the great fortieth parallel series, entitled "Descriptive Geology," and he had a part also in the preparation of Volume III., "Mining Industry." His work carried him to Virginia City in the winter of 1867–8, to Mono Lake in March, 1868, to the unknown mountain ranges of central and eastern Nevada and of western Utah in the following summer, to the Wasatch Range and to the region adjacent to Great Salt Lake in 1869, to Mount Rainier in 1870, and to the Uinta Mountains in 1871 and 1872.

Having accomplished his duties in connection with the fortieth parallel survey, Mr. Emmons, in the autumn of 1877, returned to the west and engaged in the then stirring business of raising cattle, near Cheyenne, Wyoming. When, however, Clarence King in 1879 organized the United States Geological Survey and became its first director, he sought out his friend and associate of earlier years and placed Mr. Emmons in charge of the economic geology of the Rocky Mountain division with instructions to make a detailed survey of the newly opened Leadville district. During the field-work at Leadville, which lasted until 1881, Mr. Emmons collected the statistics of the precious metals in the Rocky Mountains for the Tenth Census and in Volume XIII. ("Precious Metals") of that publication, jointly with Dr. George F. Becker,

introduced the plan of presenting outlines of the geological relations of the ore bodies in connection with the statistical data

The monograph and atlas on the "Geology and Mining Industry of Leadville" were published in 1888, although an abstract of results had appeared as early as 1882 This great work established the reputation of its author, not only with men of science, who recognized the care and thoroughness of the basal observations, the essential soundness of the deductions and generalizations the breadth of view displayed, and the masterly treatment and presentation of the material, but also with the miners, who found that they could sink shafts with the certainty of finding contacts and faults substantially as Emmons had drawn them in his remarkably accurate sections The passing years, while they have necessitated some modifications of the theoretical conclusions advanced in this monograph, have brought out more and more clearly the sound basis of honest ability and conscientious workmanship upon which lasting fame must rest The Leadville report was preceded in publication by Becker's monograph on the "Geology of the Comstock Lode and Washoe District" and by Curtis's less extensive report on the "Silver-lead Deposits of Eureka, Nevada," but with these, and probably more decisively than these, it marked the beginning of a new era in economic geology and became the model for the numerous monographic reports on western mining districts that have since been published by the United States Geological Survey

Up to a few years ago Mr Emmons continued in general charge of the investigations on western ore deposits carried on by the U S Geological Survey and many studies were planned and completed under his supervision and with his suggestive advice In some reports he appeared as collaborator—notably in those on the "Economic Geology of the Mercur Mining District" (U S Geol Survey Ann Rept, 1895), "Economic Resources of the Northern Black Hills" (Professional Paper No 26), and the "Economic Geology of the Bingham Mining District, Utah" (Professional Paper No 38), in others his share was less patent, although perhaps scarcely less important In the series of folios of the Geologic Atlas of the United States he wrote part of No 9, "Anthracite-crested Butte, Colo," parts of No 38, "Butte Special, Mont" and No 65, "Tintic Special, Utah," and the whole of No 48, "Ten-mile Special, Colo" During this period of administrative and directive work he collaborated also as senior author in the monograph (No 27) on the "Geology of the Denver Basin, Colo" (1896) and published a paper on the "Mines of Custer County, Colo" (1896)

Among the many important contributions made by Mr Emmons to scientific journals and to the proceedings of societies may be mentioned "The Genesis of Certain Ore Deposits" (1887), "Notes on the Geology of Butte" (1887), "Structural Relations of Ore Deposits" (1888), "On the Origin of Fissure Veins" (1888), "Orographic Movements in the Rocky Mountains" (1890), "Geological Distribution of the Useful Metals in the United States" (1894), "The Secondary Enrichment of Ore Deposits" (1901), "Theories of Ore Deposition Historically Considered" (presidential address, Geological Society of America, 1904), "Los Pilares Mine, Nacozari, Mexico" (1906), and "Biographical Memoir of Clarence King" (read before the National Academy of Sciences in 1903, published in 1907)

The paper on the secondary enrichment of ores was the outcome of observations and study extending over many years and it is characteristic of Mr Emmons's largeness of mind that he discussed this principle freely with his assistants and showed no haste to secure to himself priority in announcing results whose great scientific and practical importance he fully realized

At the fifth session of the International Geological Congress, held in Washington in 1891, Mr. Emmons served as general secretary and was the author of a large part of the geological guide prepared for the excursion by members of this congress to the Rocky Mountains. He was also vice-president at

the sessions of the congress held in 1897 and 1903

Mr Emmons became a fellow of the Geological Society of London in 1874 and joined in 1877 the American Institute of Mining Engineers, of which organization he was thrice vice-president While engaged in his early work in Colorado, with headquarters at Denver, he helped in 1882 to organize the Colorado Scientific Society, was elected its first president, and contributed extensively to its proceedings He also took part in the founding of the Geological Society of America, of which he was chosen president in 1903 In 1892 he was made a member of the National Academy of Sciences and he filled the office of treasurer of that body from 1902 to the time of his death He was a charter member of the Mining and Metallurgical Society of America and held active or honorary membership in many other scientific societies in this country and abroad In 1909 both Harvard and Columbia universities conferred upon him the honorary degree of Sc D

During the later years of his life Mr Emmons, freed from the cares of official administration, returned to his studies at Leadville and, in association with Professor John D Irving, of Yale University, was engaged in extending his earlier results in the light of the additional facts brought out by extensive mining operations continued through two decades Although some of this newer material was published in 1907 as Geological Survey Bulletin No 320 on "The Downtown District of Leadville, Colo," Mr Emmons did not live to see the publication of his final results which will, however, before long be issued by the Geological Survey

He was one of the founders, in 1905, of the journal *Economic Geology* and continued his able and enthusiastic cooperation in its behalf up to the time of his death

Tall in person, with a figure suggestive of activity and endurance rather than of robust strength, naturally dignified in bearing and distinctive of face, Mr Emmons, notwithstanding his genuine modesty, was a man to attract notice in any assembly One element of his forceful character was a peculiar shyness recognizable by his friends in a certain constraint of manner and bluntness of speech likely to be misunderstood by those who were unaware of his real kindness of heart and of his genial outlook on life A steadfast and devoted friend, he appeared to be incapable of cherishing resentment and his mind rose high above those petty considerations of priority and credit that too often vex and humiliate the souls of scientific men in spite of their better natures

The chief characteristics of his work were thorough painstaking honesty of method, wide and penetrating vision in the interpretation of his facts, remarkable soundness and stability of judgment, and clarity of exposition Himself able to express his thought in unusually clear and felicitous language, Mr Emmons was an invaluable critic, not only of substance but of form, and those geologists who in their younger days were so fortunate as to receive his kindly yet keen criticism, have found their appreciation of what he did for them grow more and more with the passing years and will ever hold him in grateful remembrance His own writings are an eloquent protest against the view that sound science can find appropriate expression in slovenly writing

Mr Emmons was three times married—in 1876 to Weltha Anita Steeves, of New York, in 1889 to Sophie Dallas Markoe, of Washington, and in 1903 to Suzanne Earle Ogden-Jones, of Dinard, France, who survives him He left no children

In the course of his long life Mr Emmons had seen the far west that he knew and loved so well make astonishing progress, especially in the mining industry, and he had the satisfaction of knowing that by his work he had materially advanced this development He had received unsought and bore modestly the honors that men of science most prize His name not only stood high on the rolls of science, but was known to miners throughout the Rocky Mountain region as that of the man who more than any one else had applied geological knowledge in a way to convince them

of its value Increasing physical disability neither embittered his cheerful spirit nor diminished his interest in science or in the general affairs of life When he withdrew from activities in which he would once have joined it was with the unobtrusive thoughtfulness for others that foresaw some possible hindrance that his presence might occasion His scientific associates have lost his genial sympathy, his ever ready help in worthy effort, and his ripe judgment in decisions of moment, but the inspiration of his life and character remain and probably each of those who loved him has had the heartfelt wish that when his own turn came death might summon him with like gentleness, after a life of usefulness and honor

F L Ransome

THE CONGRESS OF TECHNOLOGY

The fiftieth anniversary of the Massachusetts Institute of Technology was celebrated on April 10, 1911 On the afternoon of April 10 President Maclaurin read the address given above It was followed by an address by Professor W H Walker on the spirit of alchemy in modern industry, and by one on technology and the public health by Professor C-E A Winslow On Tuesday an elaborate program of special papers was given as follows

SECTION A—SCIENTIFIC INVESTIGATION AND CONTROL OF INDUSTRIAL PROCESSES

Chairman, Professor W H Walker

"The Conservation of our Metal Resources," Albert E Green, '07, electro metallurgical engineer, American Electric Smelting and Engineering Co, Chicago

"Some Causes of Failures in Metals," Henry Fay, professor of analytical chemistry, Massachusetts Institute of Technology, Boston

"Metallography and its Industrial Importance," Albert Sauveur, '89, professor of metallurgy, Harvard University, Cambridge, Mass

"Thirty Years' Work in Boiler Testing," George H Barrus, '74, expert and consulting steam engineer, Boston

"Coal Combustion Recorders," A H Gill, '84, professor of technical analysis, Massachusetts Institute of Technology, Boston

"An Electric Furnace for Zinc Smelting," Francis A J FitzGerald, '95, consulting chemical engineer, Niagara Falls, N Y

"Improvements in Cotton Bleaching," Walter S Williams, '95, textile expert, Arthur D Little, Inc, Boston

"The Work of Engineers in the Gas Industry," Frederick P Royce, '90, vice president, Stone & Webster Management Association, Boston

"The Chemist in the Service of the Railroad," H E Smith, '87, chemist and engineer of tests, The Lake Shore & Michigan Southern Railway Co, Collinwood, Ohio

"The Control of Thermal Operations and the Bureau of Standards," George K Burgess, '96, associate physicist, Bureau of Standards, Washington, D C

"The Debt of the Manufacturer to the Chemist," Hervey J Skinner, '99, vice president, Arthur D Little, Inc, Boston

"Prevention and Control of Fires through Scientific Methods," Edward V French, '89, vice president and engineer, Arkwright Mutual Fire Insurance Co, Boston

"Research as a Financial Asset," Willis R Whitney, '90, director, Research Laboratory, General Electric Co, Schenectady, N Y

"The Utilization of the Wastes of a Blast Furnace," Edward M Hagar, '93, president, Universal Portland Cement Co, Chicago

"Development in Paint and Varnish Manufacture," E C Holton, '88, general chemist, The Sherwin Williams Co, Cleveland, Ohio

"Reclamation of the Arid West," Frederick H Newell, '85, director, U S Reclamation Service, Washington, D C

"Some Problems of High Masonry Dams," John R Freeman, '76, consulting engineer, Providence, R I

"Some New Chemical Products of Commercial Importance," Salmon W Wilder, '91, president, Merrimac Chemical Co, Boston

SECTION B—TECHNOLOGICAL EDUCATION IN ITS RELATIONS TO INDUSTRIAL DEVELOPMENT

Chairman, Dr Arthur A Noyes

"The Elevation of Applied Science to an Equal Rank with the So called Learned Professions," Mrs Ellen H Richards, '73, instructor in sanitary chemistry, Massachusetts Institute of Technology, Boston

"The Engineering School Graduate, His Strength and His Weakness," H P Talbot, '85,

professor of inorganic and analytical chemistry, Massachusetts Institute of Technology, Boston

"Development of Mining Schools," Robert H Richards, '68, professor of mining engineering and metallurgy, Massachusetts Institute of Technology, Boston

"The New Profession of Economic Engineering," Roger W Babson, '98, president, Babson's Statistical Organization, Wellesley Hills, Mass

"Instruction in Finance, Accounting and Business Administration in Schools of Technology," Harvey S Chase, '83, certified public accountant, Boston

"Technical Education and the Contracting Engineer," Sumner B Ely, '92, vice president, Chester B Albree Iron Works Co, Allegheny, Pa

"The General Educational Value of the Study of Applied Science," Alan A Claflin, '94, president, Avery Chemical Co, Boston

"The Influence of the Institute upon the Development of Modern Education," James P Munroe, '82, president, National Society for the Promotion of Industrial Education, Boston

"The Training of Industrial Foremen," Charles F Park, '92, associate professor of mechanical engineering, Massachusetts Institute of Technology, director of Lowell Institute School for Industrial Foremen, Boston

"The Responsibility of Manufacturers for the Training of Skilled Mechanics and Shop foremen," Arthur L Williston, '89, principal, Wentworth Institute, Boston

"The Function of Technical School Laboratories," H W Hayward, '96, assistant professor of applied mechanics, Massachusetts Institute of Technology, Boston

"Technical Education—Its Function in Training for the Textile Industry," Charles H Eames, '97, principal, Lowell Textile School, Lowell, Mass

"The Contribution of the Institute of Technology toward Negro Scientific Thought," Robert R Taylor, '92, director of industrial training, Tuskegee Institute, Tuskegee, Ala

SECTION C—ADMINISTRATION AND MANAGEMENT

Chairman, Dr Davis R Dewey

"An Object Lesson in Efficiency," Wilfred Lewis, '75, president, The Tabor Mfg Co, Philadelphia, Pa

"The Scientific Thought as applied to Railroad Problems," Benjamin S Hinckley, '99, engineer of tests, N Y, N H & H R R Co, Boston

"Reliability of Materials," Walter C Fish, '87, manager, Lynn Works, General Electric Co, Lynn, Mass

"A Consideration of Certain Limitations of Scientific Efficiency," Henry G Bradlee, '91, Stone & Webster, Boston

"Scientific Industrial Operation," Tracy Lyon, '85, assistant to first vice president, Westinghouse Electric & Mfg Co, Pittsburgh, Pa

"The Trend of Commercial Development Viewed from the Financial Standpoint," Charles Hayden, '90, banker, Boston

"Profitable Ethics," David Van Alstyne, '86, vice president, Allis Chalmers Co, Milwaukee, Wis

"The Natural Increase in the Ratio of Burden to Labor in Modern Manufacturing Processes," James B Stanwood, '75, vice president and engineer, Houston, Stanwood & Gamble, Co, Cincinnati

"Scientific Management of American Railways," Samuel M Felton, '73, president, Chicago Great Western R R, Chicago, Ill

SECTION D—RECENT INDUSTRIAL DEVELOPMENT

Chairman, Professor D C Jackson

"The Elimination of some Sources of Loss in a Large Producer gas Engine Plant," John G Callan, '96, electrical engineer, Arthur D Little, Inc, Boston

"Improvements in Efficiency of Electric Lighting Properties and what the Public Gains Thereby," William H Blood, Jr, '88, technical expert, Stone & Webster, Boston, Mass

"Advent of Illuminating Engineering," John S Codman, '93, electrical and illuminating engineer with the Holophane Co, Boston

"Development of Gasoline Engines," Joseph C Riley, '98, assistant professor of mechanical engineering, Massachusetts Institute of Technology, Boston

"The Progress of Electric Propulsion in Great Britain," Henry M. Hobart, '89, consulting engineer, London, England

"Mechanical Handling of Materials," Richard Devens, '88, manager eastern office, Brown Hoisting Machinery Co, New York City

"The General Solution for Alternating Current Networks," George A Campbell, '91, research engineer, American Telephone & Telegraph Co, New York City

"Electro chemistry and its Recent Industrial Development," Harry M Goodwin, '90, professor of physics and electro chemistry, Massachusetts Institute of Technology, Boston

"Mail Handling Machinery at the Pennsylvania Railroad Terminal and United States Post Office

at New York City," Julian E Woodwell, '96, consulting engineer, New York

"The Development of a System of Underground Pneumatic Tubes for the Transportation of United States Mail," B C Batcheller, '86, chief engineer, American Pneumatic Service Co, New York City

"The Continuous Cooling of Circulating Water used for Condensing Steam," Edward F Miller, professor of steam engineering, Massachusetts Institute of Technology, Boston

"Power Plant Betterment," H H Hunt, '89, Stone & Webster Management Association, Boston

"The Development of Economical Ore Dressing Systems," Frank E Shepard, '87, president, Denver Engineering Works, Denver, Colo

"Recent Developments in Bridge Construction," Frank P McKibben, professor of civil engineering, Lehigh University, South Bethlehem, Pa

"The Manufacture and Use of Asbestos Wood," Charles L Norton, '93, professor of heat measurements, Massachusetts Institute of Technology, Boston

"The Technics of Iron and Steel," Theodore W Robinson, '84, vice president, Illinois Steel Co, Chicago, Ill

SECTION E—PUBLIC HEALTH AND SANITATION

Chairman, Professor W T Sedgwick

"Profitable and Fruitless Lines of Endeavor in Public Health Work," Edwin O Jordan, '88, professor of bacteriology, University of Chicago, Chicago, Ill

"The Technical School Man in Public Health Work," Harry W Clark, '88, chief chemist, State Board of Health, Boston

"Present Status of Water Purification in the United States and the Part that the Massachusetts Institute of Technology has Played," George C Whipple, '89, consulting engineer, New York City

"The Pollution of Streams by Manufacturing Wastes," William S Johnson, '89, sanitary and hydraulic engineer, Boston

"Sewage Disposal with Respect to Offensive Odors," George W Fuller, '90, consulting hydraulic engineer and sanitary expert, New York

"The Food Inspection Chemist and his Work," Herman C Lythgoe, '96, analyst, State Board of Health, Boston

"The Life Saving Corps of the Technical School," Severance Burrage, '92, professor of sanitary science, Purdue University, Lafayette, Ind

"Factory Sanitation and Efficiency," C-E A Winslow, '98, associate professor of biology, College of City of New York, New York City

"A Review of the Work of the Sanitary Research Laboratory and Sewage Experiment Station of the Massachusetts Institute of Technology," Earle B Phelps, '99, consulting sanitary expert, New York City

"Bacteria and Decomposition," Simeon C Keith, Jr, '93, assistant professor of biology, Massachusetts Institute of Technology, Boston

SECTION F—ARCHITECTURE

Chairman, Professor F W Chandler

"Landscape Architecture, a Definition and a Brief Résumé of its Past and Present," Stephen Child, '88, landscape architect and consulting engineer, Boston and Santa Barbara

"Some Phases of Modern Architectural Practise," Walter H Kilham, '89, architect, Boston

"The Engineer and Architect Unite," Luzerne S Cowles, '97, assistant designing engineer, Boston Elevated Railway Co, Boston

"Mill Construction with Steel Frame and Tile Walls," John O DeWolf, '90, mill engineer, Boston

SCIENTIFIC NOTES AND NEWS

Sir J J Thomson, Cavendish professor of experimental physics in the University of Cambridge, and Dr D Hilbert, professor of mathematics at Gottingen, have been elected corresponding members of the Paris Academy of Sciences

The University of Edinburgh will confer its doctorate of laws on Mr Frank W Dyson, the astronomer royal, and on Dr Ernest Rutherford, professor of physics in the University of Manchester

The University of Aberdeen has conferred its LL D on Dr A R Cushny, professor of materia medica in the University of London, on Dr Arthur Keith, Hunterian professor of anatomy in the Royal College of Surgeons, and Major P A Macmahon, deputy warden of the standards.

Dean Liberty H Bailey, of the State School of Agriculture at Cornell University, has written to Governor Dix, of New York, expressing regret that he can not accept the appointment of state commissioner of agriculture

MR. ROBERT CUSHMAN MURPHY has been appointed curator of the division of mammals and birds in the Museum of the Brooklyn Institute of Arts and Sciences in place of George K. Cherrie, who recently resigned. Mr. Robert H. Rockwell has been appointed chief taxidermist of the same institution to fill the position left vacant by the death of Mr. Critchley.

J. W. TURRENTINE, Ph.D. (Cornell, 1908), instructor in physical and electrochemistry in Wesleyan University, has been appointed scientist in Soil Laboratory Investigation, Bureau of Soils, Washington, D. C.

MR. J. B. HILL, who joined the staff of the British Geological Survey in 1884, has just been appointed to the newly-created post of geological adviser to the local government board.

THE services which Dr. Lazarus Fletcher, F.R.S., has rendered to the Mineralogical Society during his twenty-one years' tenure of the office of general secretary have been recognized by the presentation to him of his portrait painted by Mr. Gerald Festus Kelly.

THE Tiedeman prize of the Senckenberg Natural History Society of Frankfort has been awarded to Dr. Richard Willstatter for his researches on chlorophil.

DR. R. HAMLYN-HARRIS has been appointed director of the Queensland Museum.

DR. EDMUND B. HUEY has resigned his position as clinical psychologist to the Illinois state institution for the feebleminded at Lincoln, Illinois, to continue clinical research at the Johns Hopkins Hospital and in the city of Baltimore.

PROFESSOR WM. B. ALWOOD, enological chemist, in the Bureau of Chemistry, Washington, D. C., sailed on April 13 for Gibraltar and will investigate viticultural conditions in Spain, Italy, France and Germany. He will also participate as a delegate in the International Agricultural Congress at Madrid and in the International Viticultural Congress at Montpellier. Professor Alwood is on the program for papers on the discovery of "Sucrose in American Grapes" and "On the Chemical Composition of American Grapes."

THE Laysan Island Expedition from the State University of Iowa sailed on April 5 from San Francisco on the U. S. Army Transport *Sherman*. The party consists of professor Homer R. Dill, in charge of the expedition, Mr. Charles A. Corwin, of Chicago, artist, and Messrs. Horace Young and Clarence Albright assistants. These men are to be stationed on the Island of Laysan in mid Pacific for a period of about two months, and are to furnish a detailed report to the U. S. Biological Survey, Department of Agriculture, regarding the famous bird rookeries of Laysan, with special reference to the effects of the raid made on them by Japanese feather hunters about two years ago. The island is a part of a "Bird Preserve" by proclamation of President Roosevelt, and the members of the expedition are appointed as game wardens during the period of their stay. The expedition is financed by friends of the State University of Iowa, and the party has permission to secure material for a cycloramic exhibition of the bird rookeries which is to be installed in the museum of natural history of the university.

MR. MAURITZ SAHLBERG, of Sweden, is on an extended visit to this country to study hydro-electric developments for the department of commerce of the Swedish government.

ON the evening of April 5, Professor G. W. Ritchey, astronomer of the Solar Observatory of the Carnegie Institution, delivered an illustrated lecture before the Indiana University chapter of Sigma Xi, on "Stellar Photography."

DR. ELIHU THOMPSON, of the General Electric Company, lectured on March 31 to the students of Throop Polytechnic Institute, Pasadena, Cal.

WE learn from *Nature* that it is proposed, in memory of the late Dr. Louis Olivier, founder of the *Revue générale des sciences*, to publish a book containing contributions from men of science and letters who knew M. Olivier. The volume is to appear next August for the anniversary of the death of M. Olivier,

and will be accompanied by a booklet containing his portrait, a biographical sketch and a bibliography of his works

TEN thousand dollars has been contributed to the University of Pennsylvania to establish a memorial to the late Dr J A Scott, adjunct professor of medicine in that institution This memorial will take the form of a fellowship for medical research

IT is proposed to erect in Amsterdam a monument to the memory of the late Professor van't Hoff

DR CHARLES A OLIVER, of Philadelphia, known for his contributions to ophthalmology, has died at the age of fifty-seven years

MR ARTHUR RAY MATHON, instructor in mathematics at Columbia University, died on April 13, at the age of thirty years

DR JAK M VAN BEMMELEN, emeritus professor of chemistry at Leyden, died on March 14 in his eighty-first year

THE paleontologist, Professor Joseph Lahusen, died in St Petersburg, on March 8, at the age of sixty-six years

PIETER CORNELIUS TOBIAS SNELLEN, the Dutch entomologist, has died at seventy-seven years of age

THE *Bulletin* of the American Mathematical Society gives the names and theses of candidates who received doctorates in mathematics from the German universities during the academic year 1909–10 They number 38, Leipzig leading with seven About fifteen doctorates in mathematics are given annually by the universities of the United States

THE Russell Sage Institute of Pathology, which was founded in 1907 when Mrs Sage gave $300,000 for pathological research work in connection with the hospitals and charitable institutions on Blackwell's Island, has resolved to terminate the agreement existing with the Public Charities Department

THE London *Times* states that at a meeting of the Paris Academy on April 3, Prince Albert, of Monaco, announced that he would shortly commission a new steamship, the *Hirondelle II*, to take the place of the *Princesse Alice II*, which had 12 scientific cruises to her credit He informed the academy that, thanks to a new dredging apparatus, interesting specimens of the denizens of the intermediate depths of the ocean had been secured The apparatus consisted of a net, which could be dragged at a speed of 15 kilometers an hour at any depth In 1910 the *Princesse Alice* had towed this appliance at a depth of 5,000 meters, and a dozen new kinds of fish had been brought to the surface in as many days Arrangements had likewise been made for taking instantaneous color photographs of the specimens as soon as they were hauled up out of the water

ACCORDING to *Nature* three expeditions from England will observe the total solar eclipse of April 28, on Varau, a small coral island of the Friendly Group They are as follows (1) A government expedition from the Solar Physics Observatory with Dr W J S Lockyer, in charge, and accompanied by Mr F K McClean, left London on February 3, with the necessary gear, and journeyed to Sydney by the Orient steamship *Otway* From there the instruments were transhipped to H M S *Encounter*, of the Australian Squadron, and the expedition started for the Friendly Islands on March 25 (2) An expedition from the Joint Permanent Eclipse Committee will be under the charge of Father A L Cortie, S J, from Stonyhurst Observatory, who will be assisted by Mr. W McKeon, S J, and Father E F Pigot, S J Father Cortie's expedition also travelled by the *Otway* from London, and proceeded to Varau on board the *Encounter* (3) A private expedition in charge of Mr J H Worthington, who has had a special equipment made for this eclipse

PERHAPS no other metal has been used in so great a variety of ways during so comparatively brief a history as has aluminum. It is a question whether the automobile industry would have made such a remarkable progress during the last decade without the accompanying development of the metallic aluminum industry, for very many of the castings used in the manufacture of motor cars are made from this light, rigid metal The use of aluminum in the recently born art of aviation is also of great popular interest, and here again the same

qualities of lightness and rigidity recommend it Aluminum is the most abundant of all the metals It is an essential constituent of all important rocks except sandstones and limestones It is found chiefly in the silicates such as the feldspars, micas, clays, etc , and as the hydroxide in the mineral bauxite, from which it is now produced on a commercial scale Its oxide makes up between 15 and 16 per cent of the earth's crust In spite of this great abundance the metal itself was, up to 1880, a chemical curiosity, and one of the early reports of the United States Geological Survey quotes it at $1 25 a Troy ounce—$15 a pound The reason for its rarity and high price was the lack of a commercial method of extracting it easily and cheaply from its chemical combination with oxygen, for which it has a remarkable affinity With the introduction of electrolytic processes the metal has now taken a high place among the commercial metals, and from a production of 83 pounds in 1883 its consumption amounted in 1909 to the enormous total of 34,210,000 pounds, valued at approximately 23 cents a pound for ingot metal

UNIVERSITY AND EDUCATIONAL NEWS

HARVARD UNIVERSITY has received the hundred thousand dollars required for the Wolcott Gibbs Memorial Laboratory which is to form the first building of the new chemical laboratories to be erected south of the university museum It is understood that half of the sum was given by Dr Morris Loeb and Mr James Loeb It is estimated that about $65,000 will be needed for the construction of the building The rest of the $100,000 will be used for maintenance

AT a stated meeting of the trustees of Princeton University on April 13, gifts amounting to more than $90,000 were announced

DR DANIEL K PEARSONS, the Chicago philanthropist, whose benefactions to the various colleges and benevolent institutions have exceeded $6,000,000, celebrated his ninety-first birthday on April 14 and marked the occasion by distributing $300,000, including $100,000 to Berea College, $25,000 to Deane College and $10,000 to McKendree College

THE North Carolina legislature at its last meeting appropriated to the University of North Carolina $200 000 for equipment and increased the appropriation for maintenance to $87,000 a year The trustees have decided to erect first a medical laboratory costing $50,000

As has been announced in SCIENCE a bill proposing one board of control for the three educational institutions of Kansas was vetoed recently by Governor Stubbs He had proposed to the legislature a commission form of government for the institutions, five members to take the place of the eighteen now acting as regents, but a bill was passed providing for a board of three, each to receive $2,500 a year, to give their whole time to the management of the State University at Lawrence, the State Normal School at Emporia and the State Agricultural College at Manhattan As these institutions have within their walls approximately seven thousand students, Governor Stubbs believed that one man competent to plan the educational and business program for each of them would be worth much more than $2,500 This opinion was confirmed when he attempted to fill the positions and found out that the present incumbents, serving for no salaries, would not agree to continue their services The leading educators of the country telegraphed to Governor Stubbs, in response to inquiries, that the one-board principle was advisable, but the methods about to be pursued by Kansas in adopting that system were faulty, particularly in the number of members proposed and the remuneration offered. The strongest opinions against the measure came from states where a similar plan is being tried or has in the past been tried Governor Stubbs did not care to take upon himself, he said, the responsibility for disorganizing the educational system of the state and therefore he vetoed the bill

GOVERNOR LEE CRUCE, of Oklahoma, has appointed a board of education consisting of six men, to take charge of all of the state educational and charitable institutions. This board

was ordered by the recent legislature, and succeeds the boards of regents of the university, the normal schools, the deaf and dumb school, the blind school, the girls' industrial school, the university preparatory schools, the various charitable institutions, etc., and also succeeds the former text book commission. Governor Cruce, in his address to the members of this board, said in part: "I regard this board as the most important public body which has ever been, or ever will be constituted in this state. This is a radical departure from established methods, and it is impossible for me to overstate the interest and anxiety I feel for the successful outcome of your labors. I want to say, with all the emphasis that I can command, that politics absolutely be eliminated from educational matters in Oklahoma—as thoroughly as church and state are now divorced. Members of this board may be removed for cause, and I should regard it as good and ample cause for removal if any member should permit political or personal motives to influence him in the employment or discharge of persons connected with the state schools, or in any other matters coming within the jurisdiction of this board."

AT its recent session the legislature of Kansas appropriated approximately one million dollars for the State Agricultural College at Manhattan for the next biennium. The funds provide for one wing of an agricultural building, with a detached laboratory for the cutting and curing of meats. The first wing of the new building is to cost $125,000. Two more wings are to be added as the money is appropriated, each complete in itself. The legislature also provided a special fund of $22,000 to complete the armory and gymnasium, which included literary society halls, swimming pools, and complete equipment for the whole; money for experiments in the western part of the state in cooperation with the federal government, for soil surveys, also in cooperation with the United States government, $5,000 a year; for experiments in producing improved wheat, corn and other crops, $7,500 a year. The college has this year approximately 2,500 students, more, it is said, than are enrolled in any similar institution in the world. The cost per student in this institution in 1910 was $107. Kansas, with a population of less than 1¾ millions, had, in 1910, more students in colleges than had Missouri, with more than 4 million population. Illinois, in its agricultural college and university combined, had 4,638 students in 1910. Kansas, with its agricultural college and university separate, had 4,608 students, thirty fewer than Illinois, which has 6 million population.

MR. ANDREW CARNEGIE has given $25,000 to the faculty of medical sciences of London for the section of a building to be devoted to pharmacology.

AS has been noted here M. Loutreuil bequeathed $500,000 to the University of Paris. The bequest is on condition that the provincial universities also shall benefit by the revenue which is to be devoted to the encouragement of scientific studies, the equipment of laboratories, the formation of a library and the foundation of additional lectureships on scientific subjects.

DR. LAJOS SCHLESINGER, of the University of Budapesth, has been called to the chair of mathematics in Giessen as successor of Dr. Moritz Pasch.

AT Princeton University Dr. H. N. Russell has been promoted to be professor of astronomy.

DISCUSSION AND CORRESPONDENCE

THE MEANING OF VITALISM

PROFESSOR RITTER's interesting address as vice-president of Section F of the American Association[1] makes manifest once more a difficulty which confronts every one who would discuss the question of vitalism: namely, the lack of either clear or generally accepted definitions of the terms ("vitalism" and "mechanism") used to designate the opposing doctrines under discussion. Professor Ritter himself is so sensible of this difficulty that he frankly gives up attempting any complete conformity to "lexicographical authority and historical usage," and simply puts forward

[1] SCIENCE, Vol. XXXIII., No. 847, March 17, 1911, pp. 437–441.

special definitions *ad hoc*, of his own formulation, as an indication of the particular doctrines with which he is for the time being concerned. This, of course, is a perfectly legitimate procedure, but even this wise precaution can free the ensuing discussion from irrelevancy and terminological confusion only upon three conditions: first, that the definition itself be unequivocal; second, that the writer subsequently use the term only in the sense defined; and third, that the sense given to it by his definition correspond to doctrines actually held by contemporary writers worth considering, and to the fundamental principles of those doctrines rather than to their adventitious details. I am not quite sure that the first two conditions are wholly fulfilled in Professor Ritter's discussion; his definition of vitalism seems to me diffuse and of rather elusive meaning, and it does not seem altogether clear that the vitalism with which some of his remarks deal is the vitalism defined. These, however, are merely questions of verbal consistency upon which it would be unprofitable to dilate. Of more material consequence is the third requirement, for if it be not fulfilled, the discussion, however clear and unambiguous, is unlikely to be pertinent to *the* controversy over vitalism, as an important contemporary issue. Do, then, Professor Ritter's definitions really expose the nerve of that issue? I am not convinced that they do. In order, however, to avoid a merely *ad hominem* argument, I should like to suggest another way of approaching the matter which seems to me more likely to expedite an ending of the controversy between mechanism and vitalism. I shall do so by indicating in the order of their logical priority what appear to be the three essential questions involved in the controversy, and the nature of the opposing views which may be, and have been, taken upon each of these questions.

1. The first question concerns the logical relation of the "laws" or generalizations of biology to those of other sciences. The mechanistic doctrine, whatever more it may imply, at least asserts that the explanations of organic processes can eventually be found in the laws of some more "fundamental" science whose generalizations are more comprehensive than those of biology, covering some (or all) inorganic phenomena, as well as organic. The full mechanistic program would be realized if biological laws could be shown to be special cases of chemical laws, these in turn of physical, and these finally of the laws of mechanics. Roux, for example, thus sets down the aspiration of the science of *Entwicklungsmechanik*: *Das organische Geschehen ... auf anorganische Wirkungsweisen zurückzuführen, es in solche Wirkungsweisen zu zerlegen, zu analysieren.* The vitalist, on the other hand, however much more he may assert, maintains at least the impossibility of this reduction of organic processes to the laws of the sciences of the inorganic. The first article of the creed of the recent defenders of vitalism, and perhaps the one article on which they are all agreed, is the principle of *Lebensautonomie*, which is thus formulated by von Hartmann: *Aus anorganischer Materie kann das Organische von selbst, d. h. nach anorganischer Gesetzlichkeit allein, nicht entstehen.*

But what precisely is the matter at issue here, and by what test, if it were available, could the issue be decided? In what would a *Zurückführung* of biology to chemistry or physics consist? It would consist in showing that a given organic process A can be subsumed under and *deduced from* a given generalization, B, of the more "fundamental" science. The proof of the autonomy of biology, on the other hand, would consist in showing that there are modes of action characteristic of matter when organized into a living body which can never be deduced from any law that describes any modes of action of inorganic matter. But here an explanation about deducibility is needful, since the notion has been somewhat confused in some recent discussions. From *no* general law alone, even if it is known to be true, can *any* more special law, or individual phenomenon, be deduced; and this follows from the very notion of a scientific law. For such laws are generalized statements of certain constant correlations *between two or more variables*, and in order

that from the law anything more specific shall be predicted or deduced, it is necessary that there be given empirically certain information concerning at least one of the variables. Without some empirical knowledge concerning the motions or masses of some bodies, nothing could be inferred about bodies from the law of gravitation For this additional empirical knowledge about the actual values of the variables the laws themselves, if properly formulated, expressly call But the undeducibility of biological from other laws, which the vitalist asserts, is not simply the undeducibility due to a lack of the specific empirical information called for by those other laws What the vitalist maintains is that, even given a complete knowledge *both* of all the laws of motion of inorganic particles and of the actual configuration of the particles composing a living body at a given cross-section of time, you could not from such knowledge deduce what the motion of the particles, and the consequent action of the living body, would be What he asserts primarily, in short, is the doctrine of the logical discontinuity, at certain points, of scientific laws This discontinuity does not necessarily imply any breach of the principle of causal uniformity Whenever a number of particles acting in accordance with one set of laws (*e g*, of mechanics) are brought into a certain configuration, they may conceivably thereafter take to moving in ways not correctly described by the aforesaid laws, if so, the conditions under which the shift from one mode of action (*i e*, action of which a correct generalized description is given by the one set of laws) to the other mode takes place are uniform, and a new law may be formulated setting forth that very uniformity of discontinuity Again, such a view would not, in itself, deny that the behavior of organisms is a function of the number and configuration of the material particles composing them

Such a doctrine of the autonomy of a given science might conceivably be applied to other sciences besides biology. It might be held, for example, that chemistry is similarly autonomous with respect to physics, or psychology with respect to biology It might, again, be maintained that the real point of discontinuity comes, not where chemistry connects with biology, but rather where physics connects with chemistry—biological phenomena being in themselves theoretically inferrible from chemical laws, when chemical laws are more adequately known I do not now inquire whether any such views are plausible or not, I merely point out that vitalism is first of all a special case of what might be called scientific autonomism, or logical pluralism Mechanism, meanwhile, asserts the possibility of an eventual unification of scientific laws Between the two is possible an agnostic position, based upon the observation that both sides agree that no such unification is yet achieved, and that both have some difficulty in proving either that it must be or that it can not be achieved in the future

In so much of vitalism, however, there appears to be nothing that can properly be called "mystical" or "transcendental," nor anything that can especially profitably be regarded as a survival of primitive animism

2 There is, however, a doctrine which goes beyond this mere assertion of organic autonomy, and declares that (in part) the action of living bodies *is not strictly a function of the number and spatial configuration of the particles composing them at any given instant* In other words, organisms not only have unique laws of their own, but these laws can not even be stated in terms of the number and arrangement of the organism's physical components Not all who call themselves, or have been called, vitalists assert so much as this, but the neo-vitalism of Driesch maintains precisely this view, and endeavors to support it by definite empirical evidence Driesch seeks in the phenomena of regulation, regeneration and conscious behavior, evidence for the assertion that the composition (physical and chemical) of an organism, on the one hand, and its morphogenesis and activity, on the other, are (to some extent) independent variables With a radical variation in composition—*e g*, after the elimination of half the blastomeres at a certain stage of develop-

ment in certain embryos—you may, he contends, get an identical resultant form (except with respect to size). About the experimental facts there can be no question, though there appears to me to be a fairly evident flaw, of a purely logical sort, in the inference which Driesch draws from them. I do not, however, wish here to discuss the truth of vitalism, but merely to elucidate its import. But even for the latter purpose it is important to note that Driesch's vitalism by no means maintains that the specific properties or activities of organisms are not functions of *any* antecedent material or physico-chemical configuration. Whales do not develop from sea-urchin's eggs, nor does the unfertilized egg develop at all. Always you must first have given a definite mechanism, at the beginning of any morphogenetic or other vital process, and for different products you must have different original mechanisms. All that Driesch maintains is that such a process once started continues towards its normal consummation even if, after the start, some of the usual machinery instrumental to that consummation is lost and the rest has to redistribute and redifferentiate itself in order to keep things moving in the customary manner. In short, even the processes in which Driesch finds the independent variability of the physical mechanism of a living body and its physiological processes exemplified, still, even for him, have perfectly definite, perceptible and experimentally ascertainable constant antecedents, if you go back to an early enough stage in the given sequence of processes.

3. The fundamental questions concerning vitalism are the first two questions. Can some biological phenomena be shown to be, in the sense defined, autonomous? and can some of them even be shown not to be functions of any fixed configuration of material parts existing in the organism or cell at the moments at which the phenomena take place? Now, one might conceivably answer one or both of these questions in the affirmative, and stop there. Such would be the procedure of a convinced vitalist who had caught the spirit of scientific positivism. But most vitalists, undoubtedly, are not of a positivistic temper, and they have accordingly often gone on to account for the asserted peculiarity or uniqueness of organic *processes* by hypostatizing special *forces* or agents as causes of these peculiar modes of action. Such hypostases have been made in three different fashions by three recent schools of biological philosophers, of which the first would apparently refuse to be called vitalistic. The qualitative *Energetiker* (*e. g.*, Ostwald, Rignano) in so far as they set up as a real entity a specific vital or neural form of energy, having properties and modes of action not characteristic of energy in any other of its transformations, seem to imply both the autonomy of organic phenomena and the need of postulating a special dynamic background for these phenomena. The psycho-vitalists (who are indeed biological animists), such as Pauly, Francé, Strecker, find the cause of the unique modes of physical behavior distinctive of organisms in a *seelisches Innenleben*, a rudimentary form of consciousness and of purposive action, ascribed to even the simplest living things. And Driesch and Reinke and their followers, in order to explain how organisms can, as these biologists believe, pursue their typical ends even after a considerable modification or partial destruction of their usual machinery, postulate "entelechies" or "dominants" having the power, so to say, to take command even of a disabled organic ship and steer it (under certain conditions) to its destined port.

Now, it is doubtless in these vitalistic hypostases that Professor Ritter finds the trait which makes vitalism resemble savage animism. I wish, therefore, to insist upon two considerations in this connection. In the first place, as I have tried to show, the question whether it is worth while to set up such hypostases, not open to direct observation, is wholly subsidiary to questions 1 and 2, which have to do with potentially ascertainable facts concerning the *laws* of organic processes. If the verdict upon either of those questions goes in favor of the vitalist's contention, the main issue is settled. Whether, vitalism being assumed, it would be worth while to postulate

hypothetical and imperceptible forces or entities to account for the perceptible facts, is essentially a question of scientific convenience. The presumption, surely, is in favor of the positivistic method, which is content to correlate the observable data without going behind them. Yet it must be confessed that it is not by such avoidance of hypotheses concerning imperceptible causes or substances that physics and chemistry have achieved their best results. And the precedent of those sciences might be plausibly (though, I think, unwisely) made, by one convinced of the truth of the vitalistic answer to one or the other of the first two questions, an excuse for not taking his vitalism positivistically or pragmatically. In any case, these hypothetical "forces" or causes would constitute elaborations or embellishments of his doctrine, they would not constitute the basis or the irreducible minimum of it.

A word in conclusion about the position of Bergson, of which Professor Ritter speaks with cordial approval. Bergson holds the doctrine of organic autonomy in a special and a somewhat extreme form. Inorganic and organic processes manifest, in his opinion, radically dissimilar modes of causality. "The present state of an inanimate body depends exclusively upon what took place at the preceding instant. The position of the material points of a system is determined by the position of the same points at the immediately antecedent moment. In other words, the laws which control unorganized matter can be expressed in differential equations in which *time* (in the mathematician's sense) plays the part of an independent variable." This, Bergson insists, is not true of living bodies, their present state does *not* "find its complete explanation in the immediately anterior state." We must absolutely give up "the idea that the living body could be subjected by some superhuman calculator to the same mathematical treatment as that which is applied to our solar system." The "creative" efficacy of organic evolution is shown, for Bergson, precisely in the impossibility of deriving from even the most complete knowledge of the configuration of the components of an organism at a given moment, and of all the "laws" which have been disclosed up to that moment, any absolutely complete and certain knowledge of the future condition and action of that organism. Bergson, moreover, does not stop with this anti-mechanistic view of the actual behavior of organisms, he suggests an explanation for what he conceives to be the facts. And his explanation, though rather elusive, approximates that given by the psycho-vitalists. The neo-Lamarckians, he declares, are right in referring organic evolution to "a cause of the psychological order," though they apprehend this too narrowly. The conception of "effort should be taken in a sense more profound, a sense even more psychological, than any neo-Lamarckian has supposed." It is true that Bergson does not seem to call his doctrine vitalism, and that he speaks in criticism of the vitalism of certain other writers. But it seems to me that any dogmatic (*i. e.*, not merely provisional or agnostic) anti-mechanism in biology should be called vitalism. In other words, the doctrine which it appears to me to be linguistically most convenient to designate by that name is the doctrine of organic autonomy in its biological application, the assertion of an essential logical discontinuity between the "laws" or modes of action of matter dealt with by biology and the "laws" of all the sciences of the inorganic. And in this sense, of course, Bergson is an unmistakable and a radical vitalist. It would certainly be paradoxical to withhold the name from a writer who does not hesitate to say that the "parts of an organized machine do not correspond to parts of the work of organization, since *the materiality of this machine does not represent a sum of means employed, but a sum of obstacles avoided*" by the *élan vital* in its form-creating activity.

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PRODUCTIVITY OF SOILS

The discussion of the "Secular Maintenance of Soils" by Professor Chamberlin

before the Geological Club of the University of Chicago aimed at so fundamental and comprehensive a presentation of the subject and the report of it by himself in SCIENCE, February 10, p 225, is cast with such pedagogic effect that it is much to be regretted that a goodly part of the discussion was not incorporated with the report, as without this some statements are likely to be interpreted in a way widely at variance with authentic data and hence in a way to be misleading

Although most that is said is undisputed, this presentation in fifty-three terse statements of somewhat unusual form is certain to convey to younger students of the subject the impression that each and all of these phases of the great problem of soil productivity have been brought into the clear light of science and are here set out in proper order This is, of course, not true and not intended to be so understood but the great confidence accorded to the author's utterances is in danger of leading to the acceptance of his suggestions and beliefs as established knowledge, and to assigning to minor factors an importance far too great

The importance of capillarity in supplying potassium and phosphorus to crops, emphasized by the figures which are cited, will be understood as being much greater than can be the case Indeed, instead of the "capillary cycle" and the "plant cycle" tending on the whole to the concentration of potassium and phosphorus toward the surface of the soil contributing to "secular maintenance," as is implied, quite the reverse tendency is the case, as may be seen from a comparison of the composition of soils and of rocks We cite the complete analyses of 27 soils given by Hopkins[1] in the form of mean values for three depths

In this series 74 per cent of the cases in the second depth have the potassium higher than in the surface soil, and 59 per cent of the cases in the third depth have the content higher than in the surface sample The larger amount of phosphorus compounds in the surface soil is not a case of concentration due to the action of either or both cycles named, but has occurred in spite of them and is less than it would have been because of their action The most pronounced effect of both "cycles" is to leave soluble ingredients upon or above the surface of the soil whence they are transported to the sea by both surface drainage and wind action, the loss in this way being materially greater than the supply by capillarity to the root zone

Depth	Phosphorus (P) lbs per million	Potassium (K) lbs per million
0 to 6⅔ inches	581	16,376
6⅔ to 20 inches	455	16,649
20 to 40 inches	488	16,936

	Igneous Rock	Sedimentary rock Shale	Sand stone	Lime-stone
	Pounds per million			
Potassium	24,400	26,951	10,959	2,740
Phosphorus	1,100	7,426	3,404	1,747

The phosphorus content[2] of all rocks is seen to be higher than that of soils, and the higher content of sedimentary rocks will not be ascribed to either capillary or plant action, but to other processes named in the article It must of course require a positive addition of plant food elements to cultivated soils, in amounts equal to or greater than all removals, to perpetuate indefinitely uniform or increasing productivity

Studies like those of Professor Whitson[3] of phosphorus in cultivated and virgin soils indicate, in the case cited, an average loss of P_2O_5 during about sixty years, of 1,255 pounds per acre, from the cultivated soil, and in but three of the nine comparisons was the loss less than that which would be assigned to removal by crops It may fairly be questioned whether this difference is due entirely to greater loss from the cropped soils, but it

[1] "Soil Fertility and Permanent Agriculture," pp 82–87

[2] "Data of Geochemistry," Bull No 330, U S Geol Survey, pp 26–27

[3] Research Bulletin No 2, University of Wisconsin Agr Expt Station

will hardly be urged that it is even chiefly due to capillary and plant concentration such as might prevail over large areas like the United States At least the projection of such a rate of concentration through any material period forward or backward would point to very unusual if not impossible conditions

If it be true that 1,200,000 tons of PO_4 are lost annually from the soil of the whole United States by drainage into the sea and that capillary water is carrying toward the surface 18,000,000 to 40,000,000 tons, there would be a total mean movement of 30,200,000 tons of PO_4 or 9,800,000 tons of phosphorus A yearly removal at this rate maintained for 10,000 years would require more phosphorus than is carried in 10 5 feet of igneous rock, assuming 200 pounds as the weight of a cubic foot and Clark's value cited above, and all of the phosphorus carried in 40 feet of soil weighing 4,000,000 pounds per acre-foot, containing 581 parts per million of phosphorus A combined chemical and mechanical erosion which would remove 40 feet in 10,000 years, from the United States, would have to exceed one inch in 21 years

It appears to be overlooked, in making the estimates, that capillary sweeping is very often and strongly downward as well as upward, and also that a large proportion, probably more than three-fourths of the rainfall, not removed in the runoff, never penetrates the soil beyond a depth of two feet and should not, therefore, be used as a measure of surfaceward movement of plant food below that depth We have measured the combined capillary and internal-evaporation-movement out of the 5- to 10-foot depth into the 0- to 5-foot depth in four instances, two of which were a clay loam and two a sandy loam soil. The measurement was continuous through 314 days under a summer temperature Under the most favorable conditions for upward movement water was carried from the 5- to 10-foot zone into the 0- to 5-foot zone at the rate of three pounds per square foot during the 314 days, where the surface was continuously firm, while under a 2-inch earth mulch the movement was 2 2 pounds In the sandy loam the movement out of the 5- to 10-foot zone into the 0- to 5-foot zone was less than 8 pounds in 314 days The annual combined upward movement from the 5- to 10-foot zone into the 0- to 5-foot zone, at the most rapid rate, was 7 inch in the clay loam and 17 inch in the sandy loam

Assuming a soil solution containing 20 parts per million of PO_4, the total phosphorus which might thus be added to the surface five feet from the five feet below, would be but 1 to 25 pound per acre annually and even these values we regard materially too high for average conditions, although they show a rate less than one fifth that of the estimate cited by Chamberlin It is true that the capillary and plant "cycles" are agencies which, at the time, assist in the utilization of plant food substances, but they primarily accelerate their waste and should not therefore be reckoned as "efficient factors" of secular maintenance of soil productivity

We quite agree that the Mongolian races have "demonstrated one mode of effective secular maintenance of the soil productivity," but we fail to see that it is "closely analogous to the natural method of the geologic ages" Our observations bring the conviction that they return to their fields, year by year, a full measure of all potassium and phosphorus removed with their crops, that their cultural methods very largely reduce losses by both physical and chemical erosion, and that they secure a very high efficiency for the plant food used by the crops All human and animal excreta and all fuel ashes of country and city are universally applied to the cultivated fields. Enormous quantities of bean, rape seed, cotton seed and peanut oil cake are used as fertilizers annually and an enormous tonnage of canal, reservoir and river mud is also applied, even to the extent of 70 to 100 tons per acre in some instances, as single dressings which must carry to the fields not less than 100 to 150 pounds of phosphorus Then their very extensive practise of irrigation adds, with the silt and soluble plant food carried in the water, quite as much fertility as is removed by leaching, and all irrigated areas are placed

under conditions which practically eliminate surface erosion Both canal and reservoir mud, together with soil and subsoil, are fermented with organic matter to be used as fertilizers to an extent which would appear to western nations impossible Indeed it appears probable that as much labor and time are spent in specific fertilization of the fields as in seeding and harvesting the crops

While these people, so far as we can learn, have never used rock phosphates or potash salts taken from mines, as western nations are doing in recent years, they have in effect done so to a remarkable extent through their home manufacture with their compost methods So far as we could discover they have nowhere developed or applied systems of tillage looking specifically toward physical amelioration, as such, for their soils but they have practised the culture of legumes as a source of nitrogen very systematically, persistently and extensively Feed and water the crops is written on every field in China and Japan Japan is now beginning to import notable amounts of commercial fertilizers and during the years 1906 to 1908 the total import of all kinds aggregated 1,427,658 tons, with a cash value of $55,423,304 and all applied to about 21,000 square miles of tilled land, constituting a tax of more than a dollar per capita for the entire population, and this is paying for an addition to an already enormously large yearly fertilization

But the one factor which is probably equal in importance to all others is the extreme personal attention and care bestowed upon the crops, made possible and necessitated by the dense population and increasingly smaller holdings But this has not and can not supplant their supplemental irrigation and their plant feeding except through a smaller annual output It must be this factor coupled with the increasing larger return to the fields of plant food which has given rise to the increase in yield during recent years in this country and in Europe, to which attention has been called It is clear that such increase may well be coincident with a decreasing plant-food content in soils of the stronger type and for the simple reason that great care may augment the rate of production of the plant-food content of film moisture for a time, with a decreasing content of the basal food elements That the oldest and most densely settled countries should show marked increase in yield is to be expected, for here is where better care pays best, where it is compelled and where it is more readily made possible because of the denser population But it should not be ignored that the countries named are those which are largely importing feeding stuffs and fertilizers which immediately or ultimately find place in the soil, and that those who purchase and apply these have faith that they are indispensable adjuncts to better cultural methods, improved varieties and more sanitary conditions

There were imported into the United Kingdom in 1885, 282,960 tons of oil cakes, 64,387 tons of bones and fish, 25,258 tons of guano, and 238,572 tons of mineral phosphates In addition, some 300,000 tons of Thomas slag are manufactured annually and largely used at home During 1861–65 there was a mean annual importation of 1,277,778 tons of grains and beans, besides wheat During 1901–05 importation had increased to an annual mean of 4,641,201 tons A mean of these values may be taken, together with the fertilizers named, as a low measure of the annual importation of plant-food substances into the United Kingdom during the past twenty or thirty years

As a rough approximation, it may be said that 2,000 pounds of the products named will contain

	N lbs	P lbs	K lbs
Oil cakes	120	18 8	30
Bones and fish	80	170	
Guano	70	170	
Mineral phosphates		250	
Thomas slag		160	
Grains and beans	50	8	12

The arable lands of the United Kingdom aggregate 19,528,000 acres and there are 28,267,000 acres of permanent pasture.

On the basis of the amounts named the

annual importation of the three plant-food elements, including that in 150,000 tons of Thomas slag, would be

	N tons	P tons	K tons
In oil cakes	16,977	2,660	4,244
In bones and fish	2,575	5,472	
In guano	884	2,147	
In mineral phosphates		29,821	
In Thomas slag		12,000	
In grains	73,987	11,838	17,757
Total	94,423	63,938	22,001

To these amounts should be added the heavy importations of nitrate of soda and of potash salts

The phosphorus content of these importations is sufficient to apply 6 54 pounds to each acre of arable land in the United Kingdom and this amount is all that is carried in the grain and straw of 20 bushels of wheat During the twelve years preceding 1906 there was an importation of potash salts sufficient to carry 99,426 tons of potassium, which, added to the above, aggregates enough for 13 pounds per acre of the arable land Through more than a century increasingly larger importations of fertilizers and feeding stuffs have been going into all of the countries of western Europe These annual additions of soluble plant food elements to the film moisture and to the interior of the soil granules can not fail to exert cumulative effects upon both microscopic and higher plant life, which together must react upon yields continuing their increase until available soil moisture and then standing room become the limiting factors

The increase in yield in the United States to which attention has been called is certainly associated with the importation of feeding stuffs and fertilizers, and while better cultural methods, better seed, better strains and fuller control of fungus diseases are responsible for some of these increases, the addition of plant food must play a large part now in the older states, especially in the North and South Atlantic groups where fertilization has been so long and so extensively practised In the northern group, $15,641,995 and in the southern, $22,732,670 were paid for fertilizers in 1899 and applied to less than 24,683,365 and 29,194,361 acres, respectively, the amount of land in all crops that year. To give expression to these figures in terms of plant-food elements and crop yields, the mean value and composition of twelve "complete"[4] fertilizers may be used, worth $23 per ton and containing 33 pounds of N and K and 88 pounds of P On this basis the fertilizer purchased would contain sufficient phosphorus for 2 42 pounds for every acre under crop in the North Atlantic states and for 2 98 pounds in the South Atlantic states These are the amounts of phosphorus contained in the grain and straw of 7 5 bushels of wheat and 10 5 bushels of corn in the first case and in the second case, 9 31 bushels of wheat and 13 0 bushels of corn But in the most thickly settled states the amounts of fertilizer used are much above the average, Rhode Island using sufficient to carry 10 2 pounds of phosphorus to each acre in crop, Connecticut, sufficient for 6 5 pounds, New Jersey, for 6 39 pounds, Massachusetts, for 6 37 pounds, while the District of Columbia is credited with fertilizers sufficient for 26 pounds of phosphorus and of 10 pounds of potassium per acre in crop, added to her cultivated soils each year

There never has been doubt regarding the truth embodied in the statement, "that therefore there must be some efficient natural process for the maintenance of soils," but because of its association with other statements there is danger that it may be taken explicitly to mean, that therefore there must be some efficient natural process for the maintenance of soil productivity capable of sustaining, in the United States, 2,000 million people with relatively little greater effort at curtailment of waste or of return of essentials to the soil than is now practised here If all that the Chinese and Japanese farmers are doing, and for centuries have felt compelled to do, are to be included in the "some efficient process," then all danger of misleading will be removed, for there has long been more applied science in the agriculture of "oriental experi

[4] Hopkins, "Soil Fertility and Permanent Agriculture," p 157

ence" than has yet been explained or suggested by "western scientific research"

It never can be too strongly emphasized that, granting suitable climatic and physical soil condition, the fundamental of crop production is crop feeding, and that crop hunger (and thirst) has been the prime condition determining reduced yield oftener than any other These have been the tenets of practical men through all the past and are likely to remain so to the end Disease, parasitism, phagocytism, degeneration of seed, toxic substances or what not may at times reduce yields and the advance of knowledge which shall make it possible to diagnose these cases and apply the proper remedy, for each will augment the efficiency of plant food but make the demands for it greater nearly in proportion to increase of yield, and will accelerate soil exhaustion where nature or man makes inadequate return

It is difficult to see on what basis of knowledge one may contend that the increase in the productivity of soils of western Europe, referred to as occurring in recent years, has been due to improvements along any of these minor lines rather than to better physical soil condition and to the increasing application of the three most essential plant-food elements which have certainly been coincident with these increases of yield, and even more difficult does the case become when referred to the long and high maintenance of soil productivity in China where plant feeding has been the heaviest burden of the people

F H KING

MADISON, WIS

A KINETIC THEORY OF GRAVITATION

TO THE EDITOR OF SCIENCE:

Imagine a pound weight of iron raised from the surface of the earth to a point near the moon, the point so chosen that the opposing attraction of the earth and the moon shall exactly balance each other In the surface of the earth the pound-weight had some so called "potential energy of position" because it was capable of falling into a pit but in its new position near the moon this potential energy has disappeared entirely, the pound-weight, left free to move, remains stationary We can not believe that the whole or any part of it [the energy] has been annihilated it must, in some form, be resident somewhere I believe it was absorbed by, and is now resident in, the ether through which the weight was raised Conversely if this be true, a falling body must acquire its energy from the ether through which it falls"[1]

Since the ether is as yet a hypothetical substance, postulated to explain certain physical phenomena, it may be allowable in discussing some phenomena to postulate its non-existence We do not know that if the ether were non-existent and only an imaginary substance, that gravitation would also be non-existent Assuming the non-existence of ether, but gravity acting as usual, would not the pound-weight act just as is described by Dr Brush?

Consider a simple case A ball weighing one pound is lifted five feet from the floor, and placed on a shelf It has a potential energy of five foot-pounds, with reference to the floor, but it can not exert this energy, or convert it into kinetic energy, for it is prevented by the shelf So if the ball is raised to the point near the moon, it has 20,000,000 foot-pounds of potential energy, referred to the earth, and this energy could be made kinetic, if the body were "free to move," which it is not, it is restrained by the attraction of the moon, just as it was restrained by the shelf Suppose the ball is of iron, and that on being raised five feet it comes within the field of attraction of an electromagnet which attracts it and prevents it falling to the floor It has five foot-pounds of potential energy, just as it had on the shelf, but it is for the time being unavailable Let the current which actuates the electromagnet be interrupted for a fraction of a second, the ball begins to fall and the potential energy becomes kinetic In neither of these cases has the potential energy "disappeared entirely," it has only been rendered unavailable by the attraction of the moon or the electromagnet, or by the shelf It has not been annihilated nor is it "resident in the ether"

[1] Extracts from an article, "Kinetic Theory of Gravitation," by Charles B Brush, SCIENCE, March 10, 1911

The ball, the earth and the moon are portions of matter, one of the fundamental entities, or primary concepts (defining concept as that of which the mind thinks, and not an action of the mind). Gravitational attraction, a force, whether a push or a pull, is also a fundamental entity. Energy, velocity, work, etc., are complex concepts, or mathematical expressions, involving two or more simple concepts, such as, matter, space, time and force, besides the concepts of condition, such as direction, relative position and availability. The potential energy of the ball on the shelf is not merely five foot-pounds, it is five foot-pounds relative to the position of the floor, and it is not available until it is rolled off the shelf.

Consider a one-pound ball held in the hand five feet above the floor of a railroad car which is traveling eastward at the rate of 32 feet per second. It has 5 foot-pounds of potential energy and zero kinetic energy relative to the floor of the car, and $\frac{1}{2}MV^2 = 16$ foot-pounds of kinetic energy relative to the earth. If it is thrown westward at the same velocity that the car is moving eastward, it has zero velocity and zero kinetic energy relative to the earth, but 16 foot-pounds of kinetic energy relative to the car, and it is capable of breaking the window in the door of the car if thrown against it.

If Dr. Brush's kinetic theory of gravitation depends on the hypothesis that the potential energy of a body raised from the earth's surface and held by the attraction of the moon (or of a magnet) disappears entirely and becomes resident in the ether, it is not likely to meet with acceptance.

There seems to be another weak point in his theory, viz., he assumes that the long radiant waves of ether, the hypothetical cause of gravitation, "pass freely through all bodies," and yet that they cast a "shadow." These two ideas seem to be inconsistent. A perfectly transparent glass plate casts no shadow of light when rays of light pass freely through it.

WILLIAM KENT

MONTCLAIR, N. J.,
April 3, 1911

WHAT IS THE GENOTYPE OF X-US JONES, 1900, BASED UPON A SPECIES ERRONEOUSLY DETERMINED AS ALBUS SMITH, 1890?

Statement of Case.—Jones proposes the new genus *X-us*, 1900, type species *albus* Smith, 1890.

It later develops that *albus* Smith, 1890, as determined by Jones, 1900, is an erroneous determination.

What is the genotype of *X-us*, 1900, *albus* Smith, 1890, or the form erroneously identified by Jones as *albus* in 1900?

Discussion.—The nomenclatorial problem expressed in the caption of this note is solved in two diametrically opposite ways by different authors.

Some writers maintain that the original *albus* Smith, 1890, is the genotype, while others maintain that the genotype is represented by the species actually studied by Jones and misdetermined as *albus* Smith.

Cases of this general nature have given rise to considerable confusion in nomenclature, and several such cases have been referred to the International Commission on Nomenclature for opinion.

At the last meeting of the commission, the principles involved came up for discussion, but it was impossible to reach a unanimous agreement. On account of the differences of opinion, the secretary was instructed to make a careful study of a number of cases, and to report upon the same to the commission.

It is not difficult to foresee that no matter how the cases are finally decided, great dissatisfaction will arise among zoologists because the opinion rendered is not the direct opposite of what it eventually will be.

Recognizing that this is one of the most difficult cases that has ever been submitted to the commission, and recognizing the fact that regardless of our action we shall probably be criticized more on basis of our decision on this case than because of any other opinion that we have rendered, I am desirous of studying at least one hundred cases if possible, that

would come under such a ruling, before my report is formulated

In view of the foregoing premises, I respectfully request zoologists in different groups to call my attention to as many instances of this kind as possible, with which they are acquainted in their different specialties Further, since the arguments on both sides of the problem appear to be almost equally valid, it does not seem impossible that the final decision will have to be based upon an arbitrary choice between the two possible rulings, and on this account I am desirous of obtaining all possible arguments on both sides as they occur to different zoologists, and also any personal views based upon convenience or inconvenience, or other grounds, which may be held by different colleagues

I will hold the case open at least until September 1, for the presentation of arguments by any persons who may desire to submit their views

C W STILES,
Secretary of the Commission

April 1, 1911

SCIENTIFIC BOOKS

Diseases of Economic Plants By F L STEVENS, Ph D, and J G HALL, M A New York, The Macmillan Co 1910 Pp 313, 214 figures $2 00 net

The authors of this work have sought to produce a book on plant pathology "for those who wish to recognize and treat diseases without the burden of long study as to their causes" To this end "technical discussion is avoided in so far as is possible," and "no consideration is given to the causal organism except as it is conspicuous enough to be of service in diagnosis, or exhibits peculiarities, knowledge of which may be of use in prophylaxis" Non-parasitic diseases are omitted, except a few of the most conspicuous

The volume opens with short chapters on the history of plant pathology, the damage done by plant diseases, their symptoms, prevention or cure, public plant sanitation, fungicides, spraying machinery, cost of spraying, profits from spraying, soil disinfection and general diseases.

The greater part is given to brief descriptions of plant diseases due to bacteria or fungi with suggestions regarding their prevention or cure For this purpose a grouping by hosts is adopted, viz, pomaceous fruits, drupaceous fruits, small fruits, tropical fruits, vegetable and field crops, cereals, forage crops, trees and timber and ornamental plants This is a commendable feature for a practical reference book as some such classification is much to be preferred to an arrangement according to the botanical relationship of the parasite

To present in a popular way a highly technical subject and to retain accuracy and thoroughness is a much harder task than writing for professional readers Diverse opinion exists as to the most effective method of presenting such a subject It is, therefore, to be expected that many readers will differ with our authors Their attention will first be arrested by the general use of *ose* as an ending for the generic name of the causal fungus to form a common name for the disease Decay due to blue mold becomes "penicilliose", dry rot of sweet potatoes, "lasiodiplodiose", wilt of cotton, "fusariose" etc There are many arguments against such names, and it does not seem wise to attempt to introduce them into a popular book before they have been accepted by plant pathologists

Some readers will not approve the omission of all technical details relating to the nature and life history of fungi, holding them to be as essential to pathology as mathematics to a treatise on engineering The short chapter on fungi in the appendix is not adequate nor is it correlated with the chapter on pathology

It is to be regretted that it was found necessary to limit the book to diseases due to fungi and bacteria, especially since the causes of diseases are not given prominence in the text The lay reader will be confused by the omission of the physiological fruit spot of the apple, while the similar but less important fungus fruit spot is discussed. Potato tipburn is given four lines while the no more important potato scab is allotted four pages of text The wilt and dieback of the orange are omitted as is the curly top of beet, one of the

two most important maladies of that crop That the viewpoint of the author is that of parasitology rather than pathology is further shown by the omission of any discussion of the physiology of disease The very brief appendix chapter on physiology has no relation to the rest of the book

From the standpoint of the lay reader it is feared that the space devoted to remedial measures is in most cases not sufficient, nor the recommendations as definite and specific as the needs of practise require

The large number of minor diseases mentioned without adequate description will also confuse the inexperienced student

Some more serious errors occur The reviewer knows of no warrant for the statement on page 445 that *Microsphæra alni* practically destroys the pecan crop in the south in certain years This fungus is one of the least harmful of the pecan parasites Stigmonose of carnation is not mentioned while there is a reference to a more obscure bacterial disease The discussion of mosaic disease of tobacco and tomato would be cleared by including Woods's results[1]

Absurdly large losses are attributed to cotton anthracnose in Georgia, and the injury to tomatoes from *Phytophthora* is overstated The description of Bordeaux injury is incorrect, as is also the statement that blossoms are killed and the lives of bees endangered by spraying with Bordeaux

All workers in plant pathology should possess this book and it will be useful to farmers, fruit growers and all who are interested in growing plants There has long been urgent need for a treatise on American plant diseases adapted to general readers, in which the widely scattered and often unobtainable recent publications should be summarized. This book is intended to meet this need

W A ORTON

Preliminary Report on the Peat Deposits of Florida By ROLAND M HARPER Third Ann Rept Fla Geol Surv, 1910, pp 197–375, pl 16–28, tf 17–30

[1] Bulletin 18, Bureau of Plant Industry, 1902

The state of Florida because of its flatness, its abundant ponds, lakes and swamps, its ample, well-distributed rainfall and the absence of sediment-laden streams, affords exceptionally favorable conditions for the formation of peat, and the present report is a monumental disproof of that ancient and persistent fallacy that peat is formed only in high latitudes

For purposes of discussion the state is divided by the author into fourteen more or less natural divisions based chiefly upon topography and vegetation, and these are shown on a sketch map The varied swamps of the state are elaborately classified, more than thirty types being enumerated and described in more or less detail The more common plants of each are listed in the order of their abundance

A few pages are devoted to fossil peat Numerous analyses of peat samples are given and there is a chapter upon the utilization of peat This is followed by a reliable systematic catalogue of Florida peat-forming plants and the report is concluded by a bibliography and a good index

The report, as a whole, is well done and excellently illustrated by 13 plates and 14 text-figures While it is confessedly superficial, it should be remembered that the economic development of Florida at the present time would hardly warrant the investment of the large sum of money necessary for an exhaustive study of its peat deposits From the commercial view point the present report is surely ample enough to point the way to a utilization of the more important peat deposits and those which are favorably situated for exploitation

Dr Harper approaches the subject from the view point of the plant geographer, and it is this aspect of the report which has the most scientific merit and which will occasion the widest interest A more intensive study and a much fuller treatment of the flora would have been desirable from the standpoint of the botanist, but for the reasons mentioned above such a study was not practicable

The report is weak in its discussion of fossil peat, only two or three occurrences being briefly mentioned. It is very probable, however, that there are no deposits of this sort in the state which are not too small or too deeply buried to be of commercial value. At the same time, the reviewer's experience in the southern states shows that Pleistocene or older peats are more wide-spread, if not more extensive individually, than recent peats, and their botanical records are often of the greatest value. For example such a deposit just across Perdido Bay from Florida contains not only ancestral forms of *Nyssa*, *Hicoria* and live-oaks, but abundant remains of the genus *Trapa*, which is unknown in the existing flora of the western hemisphere.

EDWARD W. BERRY
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NOTES ON ENTOMOLOGY

AMONG the recent parts of the "Catalogus Coleopterorum" are part 19—Staphylinidæ (1), by A. Bernhauer and K. Schubert, part 20—Aphodiinæ, by A. Schmidt, 21—Gyrinidæ, by K. Alwarth, 22—Tenebrionidæ (2), by H. Gebien, 23—Cleridæ, by S. Schenkling, 24—Histeridæ, by H. Bickhardt, 25—Cebrionidæ, by K. W. von Dalla Torre, and 26—Scraptiidæ and Pedilidæ, by M. Pic.

A NEW French entomological journal is *Insecta, Revue Illustrée d'Entomologie*, published by the entomological station of the faculty of sciences of Rennes, F. Guitel, editor. It is a monthly, and the first number contains articles on orthoptera, coleoptera and economic entomology, all the systematic articles are illustrated.

THE peculiar larval cases of the Cryptocephalidæ and the remarkable larvæ of the Cassidæ with their highly modified tails have always been entertaining subjects with coleopterists. Mr. Karl Fiebrig has added greatly to this interest by his article on these insects.[1] The life history of a number of South American species is given more or less completely, and the plates (partly colored) illustrate many details of structure.

MR. A. M. LEA is the author of an interesting article on the beetles occurring in ants' nests in Australia and Tasmania.[2] Although the paper is a systematic one, there are notes on the habits and occurrence of many of the species. Most of the species belong to the Pselaphidæ, many are new, there are 23 species of *Articerus* and 14 of the curious long-legged Histerid—*Chlamydopsis*. A new family is based on a new genus, *Trelothorax*, placed between the Rhysodidæ and Cucujidæ, the mouth-parts are entirely concealed by the broad mentum, the hind tarsi four-jointed, the others five-jointed, it is a slender insect, with short and broad antennæ.

THE first part of the work on the aquatic flies of Germany is issued, the author being Dr. K. Grunberg.[3] This part includes all the diptera with aquatic larvæ except the Chironomidæ, which will be treated in the second part. There are synoptic tables to the genera and species and in many cases to the genera of the larvæ as far as known. Since many of the genera and a number of the species also occur in the United States, the book will be of considerable use to Americans. The arrangement of the Culicidæ is that generally followed a few years ago.

THE twenty-fourth lieferung of "Das Tierreich" is on the hymenopterous gall-flies (Cynipidæ), and is by Dr. K. W. von Dalla Torre and Professor J. J. Kieffer, 891 pages, 420 figs. About 1,200 species are treated, the genera are used in a broad sense, many recent segregates being sunk as synonyms, or subgenera. Tables are given for the galls of the old and new world. In the back is a list of genera, with references, derivation and originally included species.

[1] "Cassiden und Cryptocephaliden Paraguays, ihre Entwicklungsstadien und Schutzvorrichtungen," *Zool. Jahrb. Supp.*, 12, heft 2, pp. 161–264, 5 pls., 1910.

[2] "Australian and Tasmanian Coleoptera Inhabiting or Resorting to the Nests of Ants, Bees and Termites," *Proc. Roy. Soc. Victoria*, XXIII., pp. 116–230, 3 pls., 1910.

[3] "Die Susswasserfauna Deutschlands," Heft 2A, Diptera, Jena, 1910, pp. 312, 348 figs.

The November-December number of the Hungarian entomological journal—*Rovartani Lapok*—is a jubilee number in honor of Alex Mocsary, for his forty years' service in the Hungarian National Museum Most useful is a list of his numerous publications A list of species (65 in all) that have been named in his honor is given, to which various friends add new species in all orders in this number of the journal

Mr C C Ghosh has published an account of the life-history of a neuropterid fly—*Croce filipennis*[4] These delicate insects are but little known, and a figure of Savigny had long done duty as the only known larva of the family The larva of *Croce* is very similar to that of Savigny, with a large *Chrysopa*-like head and jaws and an extremely slender prothorax, the abdomen broad and flat They live in houses in India, and feed on silver-fish and bed-bugs The pupa is formed within a spherical cocoon, the larval stages last for nearly a year, and the adult appears for only a few days in April

Dr E Mjoberg is the author of a long article on morphology and classification of the biting and sucking lice[5] A number of species are described as new, mostly from the old world, and several new genera One, *Neohæmatopinus*, is made for *Hæmatopinus sciuropteri* Osborn He concludes that both Anoplura and Mallophaga should be included with the Psocidæ in the Corrodentia, as three subequal groups, the Anoplura more closely related to the Mallophaga than either to the Psocidæ A useful bibliography is appended.

Carl Henrich has published a large paper on German plant-lice which will be of use to our students of these insects[6] He divides the family into the usual six tribes, but appears to be unfamiliar with some of the recent generic changes

Dr N J Kusnezov brings up cases of probable viviparity in certain pierid butterflies of northern Russia[7] In examining the anatomy of certain pierids (*Colias*) he found fully developed larvæ in the lower part of the oviduct, and no chlorion around them These larvæ were bent double, with the head toward the aperture He therefore concludes that at least sometimes the larvæ are born alive, or at least so far advanced that the eggs hatch very soon after deposition The reason for this intrauterine development of the embryo he believes is the short season in the northern localities Two species of Tineids have been recorded as viviparous

Nathan Banks

SPECIAL ARTICLES

PROTECTIVE ENZYMES[1]

In this preliminary paper the authors will bring together the results which thus far show some important relations and reactions carried out by certain protective enzymes of fruits This work originated in the efforts of one of us (Cook) to determine the toxicity of tannin It is well known that tannin is one of the most abundant of plant products, and it has been repeatedly stated that it occurs in green fruits Although the work referred to above gave very definite results on the toxicity of tannin, it became evident that there was some factor or factors in the living fruit which had not been taken into consideration, making it necessary to attack the problem from the biochemical standpoint

Pomaceous fruits were most satisfactory for our purpose, although the fruit of the tomato and other plants were also used As the work progressed many difficulties presented themselves, such as the uncertain and more or less unreliable methods for quantitative determination of tannin.

[4] *Journ Bombay Nat Hist Soc*, 1910, p 530

[5] "Studien uber Mallophagen und Anopluren," *Arkiv f Zoologi*, Vol VI, No 13, 296 pp, 5 pls, 1910

[6] "Die Blattlause, Aphididæ, der Umgebung von Hermannstadt, mit einem Index und Figurenerklarung," *Verh Mitt Siebenb Ver f Naturwissensch zu Hermannstadt*, LIX, pp 104, 1 pl, 1910

[7] "On the Probable Viviparity in some Danaid, i e, Pierid Butterflies," *Hor Soc Ent Ross.*, XXXIX, pp 634–651, 1 pl, 1910

[1] By permission of the Delaware Agricultural Experiment Station

Among other things brought to light by these studies was the very great variability in the amount of tannin at different times and under different conditions It is well known that tannin occurs in great abundance in certain tissues of the plant and in injured parts, and these facts led to original studies on the possible function of tannin in plants However, we did not expect to find the great variation in amount of tannin dependent upon the length of time between the removal of the fruit from the tree and the analysis of this same fruit, for it was finally learned that there was a rapid increase in the amount of tannin or like bodies in the normal fruit immediately after removal from the plant, and that the tannin continued to increase in quantity for some time Although the greatest increase was, as previously stated, immediately after removal from the plant

For instance, a sample was taken by dropping the fruit into boiling water immediately after plucking to stop all enzyme action, and the tannin determined at once At the same time another sample of the fruit on the same tree was injured by repeated puncturing of the stem and fruit with a pin and allowed to remain on the tree for 48 hours, when the tannin was determined In the latter case the tannin was about three times as great as in the former Apples which had fallen from the tree were also analyzed for tannin and showed about twice as much as in the case where the enzyme action was stopped if such was the cause of the action However, it was thought that this action should be traced even further than shown in the above preliminary experiments and the first and best method that suggested itself (Thompson) was to follow the action by tracing the soluble nitrogen in content which would decrease if tannin or a tannin-like body was formed which would unite with the proteid bodies in the fruit juices Accordingly, juices were prepared from a number of different fruits and substances where such action might occur The materials used were green walnut hulls, ripe apples, green apples and pears; they were first ground through an ordinary meat chopper and pressed through canton flannel These juices were sampled immediately after pressing out and every 24 hours thereafter, until fermentation was apparent, the samples being filtered through asbestos by suction, and the soluble nitrogen determined with the following results [8]

Ripe apples—no decrease
Green apples—64 per cent decrease in 48 hours
Pears—14 per cent decrease in 48 hours
Walnut hulls—16 per cent decrease in 94 hours

To further prove that the action might be due to enzyme action one sample of the above walnut juice was brought to boiling temperature and kept there 30 minutes In this case for the first 48 hours there was practically no decrease in the soluble nitrogen, but after 94 hours it showed about 6 per cent

In these experiments it will be noted that there was positive proof of the formation of a tannin-like body that had the power of precipitating proteid matter, thus causing part of the nitrogen to be precipitated in the insoluble form, but as yet the nature of the enzyme was not determined further than this property, although it had been previously shown that the juices had the power of decomposing hydrogen peroxide

Therefore, a similar series of experiments were carried out by grinding the fruit with calcium carbonate, as suggested by Appleman's work on catalase, in which he showed that the activity of the catalase could be preserved by such treatment However, when the juices were filtered off and the soluble nitrogen determined, there was no decrease in any case, but fermentation set up in about 36 hours, which was a considerably shorter time than in the previous experiments.

On allowing the calcium carbonate precipitate to settle and testing both the precipitate and the supernatant liquid with H_2O_2 by the method given by Appleman, it was shown that all of the catalase was carried down by the

[8] Complete data in "The Preparation and Properties of an Oxidase Occurring in Fruits," by H P Bassett and Firman Thompson, *Journ. Amer Chem Soc*, 33. 416–423, 1911.

calcium carbonate and none whatever remained in the supernatant liquid. Accordingly, this precipitate was filtered off on a Buchner funnel and allowed to dry over sulphuric acid.

It is well known that tannin as such can not exist to any considerable extent in the presence of proteid matter, since these two substances form a precipitate, but as it has been shown repeatedly by the ferric chloride and similar tests that a body existed in the plant cells which gave these tests, the conclusion was drawn that this body must be poly-atomic-phenol that would not precipitate proteid matter. Accordingly, gallic acid was selected for our following experiments.

Therefore, a quintuple set of experiments were then carried on, one set with tannin, a second set with gallic acid, a third set with gallic acid plus enzyme, a fourth set with sodium gallate, and a fifth set with sodium gallate plus enzyme. The experiments were made by putting about 33 c.c. of liquid medium in each of a number of 200 c.c. Erlenmeyer flasks. The tannin, gallic acid and sodium gallate were added to the medium in the following proportions: .025, .05, .1, .2, .4, .6, .8 and 1 per cent. The amount of enzyme was constant throughout the two series in which it was used.

These experiments showed that the organism (*Cunninghamella echinulata*) used made its best growth in the check and in the gallic acid, and the next best growth in the sodium gallate. The gallic acid plus the enzyme, the sodium gallate plus the enzyme, and the tannic acid all showed a tendency to check the growth in the lower percentages and to completely inhibit it in the higher percentages. However, the results with the next organism (*Glomerella rufomaculans*) were radically different and led to further investigations. In preparing the enzyme with calcium carbonate, as suggested by Appleman's work on catalase, it has been shown above that the precipitated calcium carbonate carried down the catalase completely, but upon testing the supernatant liquid with guiacum it was shown that the presence of an oxidizing enzyme still existed in solution. However, upon testing the precipitate with guiacum after dissolving out the calcium carbonate and acidifying, with acetic acid, it also showed that a considerable portion of this oxidizing enzyme was carried down by the calcium carbonate, and upon drying this precipitate it was shown to absolutely lose its activity. Thus in drying the catalase precipitated by calcium carbonate the portion of the oxidizing enzyme carried down with it was killed, thus explaining the marked difference, as shown above. It should be stated here that in the first experiment referred to above the calcium carbonate precipitate was not completely dry, while in the second it was quite dry. Thus in the first case a considerable amount of the oxidizing enzyme still existed and exerted its influence on the transformation of the gallic acid into the tannin-like body, while in the second case the oxidizing enzyme had been destroyed by the drying and no such action took place to any considerable extent.

It was now evident that we had two enzymes instead of one, and that they could be completely separated from each other by their properties, as stated above, but in such a large proportion of the oxidizing enzyme carried down by the calcium carbonate precipitate it became evident that methods would have to be devised for obtaining the oxidizing enzyme from the supernatant liquid. Accordingly, the supernatant liquid was drawn off and treated by the general method for enzyme precipitation, namely precipitation with alcohol (60 per cent.). This precipitate carried practically all the enzyme down with it. This was allowed to settle and finally collected on a Buchner funnel. As it had been shown that it could not be dried, it was now prepared for use by suspension in water, and in this manner used in the following experiments. The ferric chloride and other tests on the plant cell contents showed the presence of a poly-atomic phenol, and it was evident that the formation of the tannin-like body from the poly-atomic-phenol could probably be carried out in artificial solutions. However, it has been previously shown by Bertrand in work-

ing with laccase prepared from the sap of the lac-tree, and Lindet with an oxidase found in cider and wines, that these enzymes possess the property of oxidizing certain poly-atomic-phenols, e. g., hydroquinone to quinone and pyrogallol to purpurogallic. Thus the following experiments were planned to study this property of the enzyme by preparing artificial solutions of gallic acid and albumen and measuring the rate and extent of the formation of the tannin like bodies by the decrease of the soluble nitrogen.

Accordingly 500 c.c. quantities of the following solution were prepared:

No. 1—gallic acid alone, 4 per cent
No. 2—gallic acid and enzyme
No. 3—gallic acid and enzyme
No. 4—gallic acid, albumen and enzyme
No. 5—gallic acid, enzyme and albumen
No. 6—enzyme alone

The albumen used was a solution of egg white which had been filtered through absorbent cotton and contained 1.36 grams of nitrogen per liter. The enzyme was prepared from pear juice by grinding fruit in calcium carbonate, pressing out the juice and allowing it to settle, drawing off the supernatant liquid and precipitating the enzyme with 60 per cent alcohol, collecting on Buchner funnel, and suspending this precipitate in distilled water. Fifty cubic centimeters of this suspension was used in each case. A series of experiments similar in every particular except 50 c.c. of 3 per cent hydrogen peroxide was added in each case, and was carried out in the same time. In about an hour after the enzyme had been added a very heavy flocculent precipitate had formed and settled, in those flasks containing all three constituents, viz., gallic acid, albumen and enzyme. Those containing gallic acid and enzyme without albumen had turned a rich wine red color, presumably from the oxidization of the gallic acid.

Samples of 50 c.c. each were taken after 15 hours, and every 24 hours thereafter until there was no longer any decrease in the nitrogen or until the solution showed signs of fermentation.

No. 2 containing gallic acid and albumen, showed no change in soluble nitrogen after 5 days.

No. 4, containing gallic acid, albumen and enzyme, showed a marked decrease in soluble nitrogen amounting to 70 per cent in five and one half days, 26 per cent being precipitate in the first 15 hours.

The corresponding solution containing hydrogen peroxide showed a similar decrease, but was considerably more rapid, amounting to 47 per cent in the first 15 hours.

Having made this further investigation, as outlined above, thus determining some of the properties of this oxidizing enzyme and at the same time explaining our former results, it was now desirable to try the effects of this pure enzyme preparation upon certain fungi. Therefore *Cunninghamella echinulata*, *Glomerella rufomaculans*, *Pestalozzia brevisela* and *Penicillium aureum* were used in a quintuple set of experiments according to the method previously referred to, but using the pure oxidase instead of the calcium carbonate precipitate. In all cases there was decided action increasing with the increased amount of gallic acid or sodium gallate used.

Since the above experiment showed such high toxic effects which could not all be accounted for by the fermentation of the tannin-like body, it was decided to carry out further experiments on the germicidal properties of the solutions formed. It had also been previously noted that the juices that had been prepared by grinding with calcium carbonate, and in which there was apparently no action of the enzymes fermented much more readily than the juices that had been prepared by grinding without calcium carbonate, and it was evident that the other bodies formed in the reaction might have some germicidal properties. Accordingly, six days after the experiment with gallic acid to show that the precipitate of the soluble nitrogen had been started, plate cultures on agar-agar and gelatine were made from the solution containing gallic acid and albumen, gallic acid, enzyme and albumen, enzyme and albumen. Cultures in beef tea were also made at the same time

Ninety-six hours after the setting of the cultures the following results were noted. In both cases where the gallic acid and enzyme were not present together there was a heavy fungus growth, but in both cases where they were present together there was a very slight growth in all media. Thus the conclusion would be that the body formed by the action of the enzyme and gallic acid had a marked inhibitive effect on fungus and bacterial growth. It was apparent that for these germicidal effects to be of any value to the fruit it would necessarily have to have quite a rapid reaction in order to keep out any chance of infection, and also from the almost instantaneous appearance of the precipitate, and from the data obtained for the transformation of the soluble nitrogen it was inferred that the action was comparatively rapid, and accordingly an experiment was planned to obtain further data on this point. A solution consisting of 100 c.c. of albumen solution, 200 c.c. of 1 per cent. gallic-acid solution, 50 c.c. of enzyme suspension, and 50 c.c. of 3 per cent. hydrogen peroxide was prepared and diluted to 500 c.c. Another solution which was the same in every respect with the exception of the hydrogen peroxide, which was omitted, was prepared at the same time. Samples of these two solutions were taken every fifteen minutes, for about two hours, and the soluble nitrogen determined. The solution could not be obtained clear on filtering and no flocculent precipitate separated out as in the previous cases. The determinations of nitrogen also showed no decrease in the soluble nitrogen. Thus it was apparent that for some reason the action was not taking place as before, but on adding 60 c.c. more of the enzyme suspension in each case, a heavy flocculent precipitate immediately formed and settled rapidly, and the first sample was taken ten minutes later, filtered as rapidly as possible, and the soluble nitrogen determined showed a decrease of 42 per cent. in the solution containing the hydrogen peroxide and 53 per cent. in the other.

The same experiment was then repeated with the constituents in the same proportions, but the quantity of the enzyme suspension was increased to 150 c.c. The flocculent precipitate appeared at once and settled immediately. Samples were taken every 15 minutes for the first hour, and at longer intervals thereafter for 4½ hours. The decrease in the soluble nitrogen amounted to about 30 per cent. in the first 15 minutes in the solution containing the hydrogen peroxide, and about 23 per cent. in the other. There was, however, practically no further change in the soluble nitrogen, up to four and one half hours, when the sampling was discontinued.

These results no doubt show conclusively that the action carried out by the enzyme is very rapid, but will take place only when the concentration is above a certain undetermined minimum, which point is of very great importance when acting as a protective agent for the fruit.

Analysis of the fruits (apples and pears) made throughout the season, where identical conditions were adhered to, showed a gradual decrease in tannin content. It is well known that fungus parasites increase in activity throughout the season and are most destructive as the fruits approach maturity. Later in the season tests were made for the determination of the localization of the enzyme in the fruit by the use of the guiacum solution, which showed that in the case of pears the blue color developed first around the core and immediately under the peel, but finally developed uniformly over the freshly cut surface. As cold weather approached, the pears were removed from the trees and stored in a cool, dry place, by which means it was hoped that the work might be continued for some time. An attempt to prepare some of the enzyme from these pears eight days after their removal from the tree resulted in a preparation which had lost practically all its power. On testing the freshly cut surface with guiacum solution no blue color was developed, excepting rather faintly immediately around the core. The supply of pears having been exhausted, apples were examined in the same manner from time to time, and showed a gradual decrease in the amount of enzyme

until to date (February 8 1911), showing only a slight trace around the inner part of the core

It is interesting to note that early in the season several normal fruits were injured by passing a sharp instrument through them from side to side and allowing them to remain on the tree for 48 hours thereafter A section was then made through the injury and the guiacum solution applied The blue color developed first quite strongly around the walls of the injury, followed gradually by the other parts of the pear

From the preceding it will be readily seen that there exists in the normal living fruit two enzymes, a catalase and an oxidase The latter is probably most abundant in the early part of the season, gradually decreasing in activity as the fruit approaches maturity and ripens Furthermore, from the above results it appears that tannin as such does not exist in any part of the normal, uninjured fruit previous to maturity, except possibly a small amount in the peel, but exists as a poly-atomic phenol, which upon injury is acted upon by the oxidase and forms a tannin or tannin-like body having the property of precipitating proteid matter, and at the same time forming a germicidal fluid This oxidase acts only in an acid solution, and when present in an amount above a certain undetermined minimum The above conditions are always present in normal immature pomaceous fruits When normal, immature fruits are subjected to injury by fungi, insects, or mechanical agencies, the action of the oxidase on poly-atomic-phenol is brought about with the effects as stated above

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THE RELATION OF PERMEABILITY CHANGE TO CLEAVAGE, IN THE FROG'S EGG

UNFERTILIZED eggs (taken from the uterus) of the wood frog, *Rana sylvatica*, were caused to assume the normal orientation in the jelly, and to segment, by electrical stimulation An alternating current of 60 cycles and 110 volts was passed through the tap water containing the eggs, from platinum electrodes about two inches apart Stimulation for one second seemed to give the best results The eggs were placed in fresh water immediately after stimulation

Similar eggs were caused to segment by mechanical stimulation, even while the jelly remained intact However, the most reliable mechanical means of inducing cleavage was found to be Bataillon's method of pricking the egg with an extremely fine needle The first cleavage furrow often passed through the point of puncture

Thousands of eggs were operated on Control eggs were kept to both sets of experiments, and showed no segmentation or rotation within the jelly

The following indirect evidence is given to show that a change in permeability is associated with both of these means of inducing cleavage

1 These "stimuli," if applied in greater intensity or duration than is necessary to produce cleavage, result in rapid osmotic exchange with the medium and death of the egg

2 Similar electrical and mechanical "stimuli" produce segmentation in the sea-urchin's egg, a process which I have shown to be preceded by an increase in permeability

With the exception of the rate of oxidation, this change in permeability is the only known common intermediate step between fertilization or artificial "stimulation," on the one hand, and cleavage on the other Furthermore, there is indirect evidence to show that increase in permeability is associated with fertilization, in the frog's egg, as I have shown to be the case in the sea-urchin's egg Backman and Runnstrom[1] observed that, whereas the osmotic pressure (freezing point lowering) of the ripe ovarian egg of the frog is the same as that of frog's serum, the osmotic pressure of the fertilized egg is the same as that of the pond water in which it lies Since the frog's

[1] *Biochem Zeitschr*, 1909, XXII, 390

egg does not swell enormously after oviposition, it is improbable that the fall in osmotic pressure is due to the absorption of water The simplest explanation is that the egg is, at this time, permeable to the internal osmotic substances That this permeability is only a temporary condition is indicated by the fact that the osmotic pressure of the resulting embryo rises until it reaches that of frog's serum

In conclusion, I wish to thank the Carnegie Institution, and especially Dr Chas B Davenport, the director of the laboratory

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April 3, 1911

THE BACTERIOLOGY OF "TATTÉ MELK"

This milk is a favorite food article in Norway and Sweden and is prepared by inoculating sweet cow's milk with leaves of *Pinguicula vulgaris* or with a small amount of the finished product Sometimes pieces of linen are dipped into the fermented milk, allowed to dry, and used for inoculation This method makes it feasible to send the material by mail The milk is thick and slightly stringy and has a slight cheesy taste and odor

I obtained three samples of the milk and one of the impregnated linen from a reliable source for the purpose of determining the active agents in it A microscopic examination of the samples showed streptococci in large numbers, mostly in diplococcus form, but frequently in chains of ten to sixteen members Two species of yeasts were also in abundance, one being an oval yeast, the other a large organism with square ends, often forming long filaments Besides these organisms there were present some bacilli resembling *B coli* in shape and size, which proved to be gram-negative There were also a few large bacilli resembling that group of bacilli, which is found in milk almost invariably and forms larger amounts of acid than ordinary lactic acid bacteria Microscopic examination of the impregnated linen did not show yeast cells

Plates were prepared from the four samples in dextrose-litmus-agar and in beerwort agar, litmus milk was inoculated with the original material The milk, when intended for consumption, is inoculated at body temperature, and therefore all plates and cultures were incubated at 37° C

There was no difficulty in isolating the different organisms from the plates The streptococcus could not be distinguished microscopically from *S lacticus*, but its action on sterile milk differed in that it coagulated but slowly, after coagulation the coagulum was stringy, similar to the coagulum formed by *B bulgaricus*, but in a smaller degree The oval yeast gave the microscopic picture of *Saccharomyces cerevisiae* It ferments lactose and saccharose with violent gas production, levulose slowly, and maltose not at all Cultures of this yeast in liquid beerwort impart a somewhat stringy consistency to the medium The other yeast proved to be *Oidium lactis*, which is always present in milk and in this milk is probably responsible for a slight cheesy taste and odor

Cultures of the samples were also made in broth with the addition of 2 per cent dextrose and 0 5 per cent acetic acid The presence of the acid restrains most bacteria, so that those forming a large amount of acid can be detected by this method Dextrose also favors the growth of these bacilli After twenty-four hours' incubation they were found in abundance in the cultures These organisms, however, do not multiply readily in milk in competition with other bacteria and I do not believe that they have any bearing upon the production of "Tattó Melk" In fact sterilized milk, inoculated with streptococci, isolated from the samples, and with the two species of yeasts, resembled the original product closely after twenty-four hours Whether the yeast has anything to do with the stringiness of the milk is doubtful, but it adds to the palatability of the milk It does not produce nearly as much gas in the milk as it does in pure culture

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PERMIAN REPTILES

THE relationships of the South African and American Permian faunas have long been of profound interest, from both the geological and evolutionary standpoints. Students have now generally come to an agreement in the union of all the Permian and Triassic stegocrotaphic reptiles (exclusive of the Chelonia) under the single order Cotylosauria, but, until recently, the zygocrotaphic terrestrial reptiles have been distinguished under five or six ordinal names, though Broom is willing to unite the African forms under the ordinal or superordinal term Therapsida.

Within the past few years, beginning with the important collections made by Professor Case, the University of Chicago has acquired a very rich representation of the American Permian reptiles and amphibians, some six or seven of the thirty odd genera acquired represented by practically complete skeletons. Among the latest of these collections, discovered the past year by Mr. Paul Miller in the vicinity of Seymour, Texas, is a very nearly complete articulated skeleton of the remarkable genus described a few years ago as *Seymouria* by Broili, from two incomplete skulls. Almost nothing of the remainder of the skeleton has hitherto been known. Within the past year I described and figured a considerable part of a skeleton of a very small reptile, based upon two specimens of nearly identical size, under the name *Desmospondylus*, suggesting at the time the possible identity with either *Seymouria* or *Pantylus*. The name proves to be a synonym of *Seymouria*. Although the two specimens described are scarcely a third of the size of the adult, and both of the same size, they doubtless are juvenile, or embryonic. I also suspect that *Conodectes* Cope is the same genus, or at least is a closely allied genus, but the name is unworthy of priority, since the type was never really described or figured.

Seymouria presents such extraordinary characters, that, if we raise the Diadectidæ, Pariotichidæ and Pantylidæ to subordinal rank, as would be justified from the characters used to distinguish the South African groups, we must also elevate the Seymouriidæ to the same rank. I am, however, opposed to the erection of so many ordinal names, they are in large part merely confessions of ignorance. The family Limnoscelidæ, for instance, recently described by me from the Permian of New Mexico, shows certain intermediate characters between the Diadectidæ and Pareiasauridæ. For the present, it seems to me that the following classification will suffice: Order Cotylosauria, families Diadectidæ (Nothodontidæ Marsh), Limnoscelidæ, Pariotichidæ, Seymouriidæ, Pantylidæ, Pareiasauridæ and Procolophonidæ, the last two exclusively African and European, the others exclusively American.

And I would go still further, possibly some will think too far. The possession of a very perfect skull of *Edaphosaurus*, hitherto known from imperfect material only, convinces me that Broom is right in his acceptance of the views previously held by Cope, but which for some years have fallen into desuetude, that the African and the American therocrotaphic reptiles (that is, those with a lower temporal vacuity only) are likewise related in the same way and perhaps in the same degree. Broom would still retain their ordinal distinction, but I am disposed to go further and reunite them under the name originally applied by Cope to the Pelycosauria and Anomodontia—Theromera or Theromorpha. The working out of the genus *Casea*, recently described by me, has disclosed many aberrant characters, separating the genus more widely from the Pelycosauria than are any two groups of Broom's Therapsida. But, I repeat, I am not willing to make so many new orders, it serves no useful purpose, and both *Edaphosaurus* and *Casea* would require ordinal distinction if we accept the groups of Therapsida as orders. I therefore propose the following classification of the therocrotaphic reptiles (excluding the Theriodontia): order Theromera, suborders Pelycosauria, Poliosauridæ, Edaphosauridæ, Caseidæ, Aræoscelidæ (?), Therocephalia, Anomodontia, Dinocephalia and Dromasauria, the first five American, the others African. I leave the

family termination to some—one can do what he chooses with them S W WILLISTON

SOCIETIES AND ACADEMIES

THE PHILOSOPHICAL SOCIETY OF WASHINGTON

THE 691st (40th anniversary) meeting was held on March 11, 1911, President Day in the chair The evening was devoted to hearing the annual address of the retiring president, Mr R S Woodward, who spoke of the "Meaning of Research"

The speaker mentioned the importance of the time element in measuring progress in research, and stated that we are often prone to measure progress by months and years instead of decades As a study of the society may throw some light on the meaning of research, the speaker briefly reviewed the great work the Philosophical Society, which is yet young, has done, what it is for and what it may do

The society has had thirty two presidents, of whom the speaker had known all except two, and he had worked with two thirds of them The chief work of many of these were mentioned Forty years ago was a time of profound intellectual agitation, the principal cause of which was Darwin's "Origin of Species," and it is probable that the Philosophical Society was due to the great influx of new ideas coming at that time Stirring intellectual enterprise (not repose) was the order of the day At that time biology was the most conspicuous sign of the intellectual uprising, the work of Kelvin and Tait, and Maxwell was not more revolutionary than Darwin's Progress has since been at an accelerated rate Applications of results of physical science have multiplied ten to one hundred fold

The development of scientific work by the government was described at some length, mention being made of a number of departments and individuals therein that have contributed to both practical and theoretical results in many branches of science, including medicine, most of which had been done by members of the Philosophical Society The characteristic features of research by members of the society during these years were mentioned

Research has not been understood by the masses, and has not generally been recognized as a vocation The methods of science are now coming to be recognized by all as the best method for the discovery of truth The meaning of research is best recognized by the fruits of this and other similar societies

The chair expressed the thanks of the society to the speaker for his excellent address The address will soon appear in full in a bulletin of the society

THE 692d meeting of the society was held in the new auditorium of the National Museum on March 25, 1911, this being a joint meeting with the Washington Academy of Sciences The evening was devoted to hearing an address by Dr Svante Arrhenius, by invitation, on the subject of "The Atmosphere of the Planets"

The constitution of the sun and its probable temperature were briefly mentioned Owing to its gaseous condition the specific gravity of the sun is about one fourth that of the earth, that of Jupiter and Saturn being about the same as that of the sun The majority of the planets are void of an atmospheric envelope The moon's atmosphere is about one thousandth that of the earth

The critical velocities of bodies at the earth and at the moon were mentioned In speaking of the critical velocities of various substances at the moon it was stated that hydrogen and helium had long ago flown off from the moon

The minor planets, lying in orbits between the sun and Mars, have no atmosphere Mars, Venus and the earth only, have an atmosphere Venus has a very heavy atmosphere and which is now like that of the earth ages ago

Laplace's theory of the extension of the sun's gases to Neptune and Uranus was mentioned

The question of how the earth got its present atmospheric properties was discussed When the temperature of the earth reached 55° C organisms could live The polar regions of Venus are about 60° C and organisms may live there

In discussing the important function of the existence of CO_2 in the atmosphere, it was stated that the time will come when the amount of it will dangerously decrease, and finally all of it and some of the water will go from the earth, the earth will grow colder and the rest of the water will freeze

Mars is now a desert with a low temperature, its atmosphere is about one twentieth that of the earth This will nearly all vanish, especially when the sun's radiation allows Mars to cool down This is the fate of all planets

President Day, of the Philosophical Society, thanked the speaker, on behalf of the joint meeting, for his very interesting address

R L FARIS,
Secretary

// SCIENCE

FRIDAY, APRIL 28, 1911

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BOTANICAL TEACHING[1]

I ON THE PREPARATION OF BOTANICAL TEACHERS

SOME months ago a suggestion was made that at this dinner we should ask ourselves the question Why is it that with the enormous classes we are having in botany there is a marked dearth of properly trained men who can serve as instructors in colleges and universities?

In order to be sure that I was right in regard to such a dearth I wrote to something like a dozen of the professors of botany in prominent institutions in the country, making the inquiry whether they had noticed the same thing, and uniformly the answer was that there seems to be a shortage in the supply of material for instructors (in the college sense) and young men for other minor positions

I think there is no lack of men who are ready to be professors of botany I am very certain that there is no trouble here, but when a professor who knows what he wants asks for a man who can take up this work or that work as an instructor, the situation is quite different

What becomes of the great number of students who are in our classes? The professor of botany in the University of Minnesota tells me that he has over 500 students in his beginning classes In Nebraska we have about 350, and elsewhere I find essentially the same thing Enormous classes are pursuing general botany, and

[1] From the stenographic report of oral addresses delivered at the conference on botanical teaching at the dinner for botanists, Minneapolis, December 29, 1910

yet so few are going on and qualifying for even the minor teaching positions.

In talking this matter over recently with a clergyman, who is also a botanist, he said, "The truth is there is less real scholarship among students to-day than there used to be," and I think there is a grain of truth in his remark.

I stopped our professor of Greek the the other day and asked him what he thought of our botanical problem. He said, "It is just because the students have got into the way of taking nothing but first-year work. They take first-year Greek, and that is the end of it, first-year college Latin, first-year geology, first-year philosophy, first-year physics, first-year astronomy, and first year American history, and so on." There is a good deal of truth here too.

Here then is something to be thought of. Students in the universities are taking beginning work only, and botany suffers with all other subjects. As educators we should give serious consideration to this matter. It is not right that we should permit pupils to be taking these little educational bites of all kinds, and in any sequence; on the contrary they should be required to sit down to a good square educational meal taken in proper order.

It makes one sick at heart to witness what is actually going on in the universities under our very eyes. We spread out before the students the courses we have to offer, and in tempting phrase try to induce as many as possible to enter our classes. I am reminded of the proprietors of bazars who have trinkets for sale, and try to induce every passer-by to purchase, by loud insistence upon the advantages resulting from such a transaction. And the bewildered student is left without a guiding suggestion in the bulky catalogue. Oh, the folly and the cupidity and the cowardice of the system that bids the student make a wise choice, but gives him no guide! Had I the power I should certainly sweep out of existence all of the go-as-you-please arrangements in the universities, and I should substitute for them a logical and carefully selected sequence of studies.

There is no doubt that many young men turn from botany into various related subjects, as agronomy, horticulture, forestry, etc., and I have no complaint to make if they do, but these subjects do draw students away from scientific botany, and so reduce the number available for teachers.

Nearly every one of the professors to whom I sent inquiries referred to the low remuneration that comes to the young man who has fitted himself to be an instructor in botany in college or university. And no doubt this is a potent factor, and it is likely to turn away many of the best men from the teachers' ranks. The fact is that a bright young man looking to his life-work will be turned more or less this way or that way, as he sees that the world is ready to pay him for it. Now I dislike to have to say this; we like to think that the best men will go forward if they have to go with only a crust a day, and all that. There is very little truth in it, however. We ourselves go where we find employment and adequate remuneration. And so young men are lured away from botany with its low remuneration, leaving us too frequently only the poorer men.

Now we do not like to acknowledge this condition of things. We like to think that science is a sacred calling, something apart from business, and we do not like to acknowledge that a man who has the scientific spirit in him can possibly be turned aside by any thing like a salary. But botany is a business, and it is not sacred any more than selling shoes or editing a newspaper is sacred. And as most men

can succeed in more than one of several pursuits, so most men can succeed in botany if they take hold of it seriously Here again we do not like to acknowledge the truth of this statement, we think that we are made of different kind of stuff But I do not believe it for a moment I have no doubt that some of us here might have been millionaires if we had gone into business What I want to insist upon is this that we look at this matter squarely, and not try to make out that we are a different kind of people, and made out of different material We are not, and our business isn't any different, it isn't any more sacred We must be candid in this matter and admit that our profession hasn't anything sacred in it, there is no sacred fire that must touch every man before he can be a botanist There is nothing in this sentiment As I said before, botany is comparable to the selling of shoes, or the running of a newspaper Botany is not extraordinarily difficult, and it does not require geniuses, only just good ability and perseverance, that's all So men who might have been botanists will continue to choose other vocations, and some others will choose to become botanists, and some of either will fail, and some will succeed, just as is always the case Some men who might have become brilliant botanists will become brilliant business men instead It has been said that "botanists are born and not made" Maybe they are, but if so, they are born with a multiplicity of other possibilities also

Brethren, let us remember that we are quite like other men, and that with us the factor of remuneration cuts as great a figure as it does elsewhere in society, in the selection of a vocation

Many of those to whom I wrote expressed doubts as to the wisdom and effectiveness of some of our teaching, and out of these doubts that have been passed along to me I obtain these suggestions

There is some faulty elementary instruction, probably I should have said much faulty instruction Again, we do not begin early enough in bending the human twig in the right direction to make a good botanist There is a good deal of improper presentation We too often try to offer "attractive" courses for the sake of drawing students into our work And this is necessarily fatal to a scientific presentation Some of my correspondents suggest that there are such persons as incompetent assistants who supervise our laboratories, and by their incompetence tend to drive away some men Further, it has been suggested that probably there is nowadays too great a neglect of field work It used to be that in vacation time the young botanist had something to think about, and something to do He could go out in the woods on long botanical trips He can not do this to-day if he is a mere laboratory man He can not conveniently carry his microscope along with him A vasculum is a great deal easier to carry than is a microscope, and far easier to handle I think my correspondent was right we have lost something of our hold on young men because we have nothing to substitute for the old-time field botany You can not do laboratory work in vacation Of course you can go to summer school, and sit down by the side of a lake and study some of the algæ found there, but even that doesn't compare favorably with the old-time tramping for miles and miles through the woods and swamps, with a vasculum slung over your shoulder

Some of my correspondents suggested that there is too much narrow training nowadays I think this probably comes rather close to some of us We get hold of a bright young fellow after he has had a half year's work, or little more, and put him

into something that narrows him to a single line of work. He makes a good specialist, but he is too narrow for a botanist. He is far too narrow a man to be put in charge of classes in general botany.

Again, I think we set our requirements too high for the young teacher. We demand much more than is really necessary. We older men forget how very little we knew when we began teaching. We act as though we felt that men must be stuffed with every detail of technical knowledge before they are ready to be sent out as teachers. We want these men to be prepared all around, and well prepared, too. This is all right enough when you are thinking of specialists to fill positions calling for a particular preparation. But when the inquiry is made for a young man to be an instructor we should go back to our own experience. We did not know much, but we got on somehow, and our classes seemed to learn from us. Yet to-day we act as though we felt that we must send out young teachers who are perfect machines for any kind of botanical work. We act as though we were not sending out men with initiative and with ability.

Let me illustrate my meaning by an example. A few years ago the government sent to Nebraska for a young fellow who was not especially well prepared in botany and took him to Washington, and after a few days shipped him down to Alabama, and put him in charge of a group of men. They were studying pecan tree diseases. This man from northern Nebraska, who had never seen a pecan tree, found himself in charge of a squad of men engaged in budding pecans. He knew nothing about budding pecans. But he had initiative enough to master the situation, and after a night's study and practise he went ahead as though he had been budding pecans all his life, *and succeeded!* I did not train that man in pecan budding, in fact I could not have recommended him as a budder of pecans. Yet he "made good," not because he had been stuffed by the right kind of knowledge, but because with his foundation of knowledge he had energy and ability.

Now let us ask whether we are not setting up a wrong standard? We are thinking of how full a man is of the botany we have put into him. Should not our attitude be this: "this man has made a good beginning, he has the right kind of material in him, take him and let him grow up with his work."

Now there is not one of you here who has not learned ten times more of botany out of college than he learned in college. You had the qualities in you to make you successful, and had a fair beginning in the science. I was quite interested in looking over the summaries in the second edition of the "American Men of Science" to find that the botanists are requiring young men to work longer for their bachelor's and doctor's degrees than are the chemists, physicists, zoologists, mathematicians or geologists. I do not believe botany is proportionally that much harder. We are putting too high a value on what we are *putting into* our students, and neglecting the man himself. We are in danger of having men grow "stale," as the athletes say. Probably we keep our men with us too long. We should send them out while they are still fresh and vigorous.

I think we should map out very definitely a series of successive semesters of work that should constitute fair preparation for the average young man who wishes to become a botanist. Such a botanist should be ready to begin teaching, or even investigating, not as an expert, but as a beginner. And every one must necessarily be a beginner in his work at one time in

his life Let us think of these young men that we are suggesting for positions as beginners merely, and when you send one to me I shall take him as a beginner, not as a finished botanist Yet very commonly we say to our students that they can not begin either investigating or teaching until they have made a special study in particular fields We try to impress them with the great importance of graduate work, and the littleness of their present knowledge, and we impress upon them also our conviction of their general inability

We need broad general courses with definite beginnings and endings, and including something of all the phases of the science, well wrought together into one science, and not courses consisting of a collection of disjointed and disconnected phases of the subject I think here is one of our mistakes As one of my correspondents wrote very emphatically, "this splitting up of the science so that the student thinks of it as morphology, so many hours, physiology, so many hours, pathology, so many hours, and mycology, and algology, and bryology, and taxonomy, etc, has done much to discourage young men"

No doubt also we can help to make more botanists by encouraging an *esprit de corps* among our students, whether they are undergraduate or graduate students All are botanists, even the newest recruit belongs to the botanical army Let us not withhold honor from these new additions to our force And yet I have seen in many places a tendency to persistently belittle the knowledge of the student in his first and second years on the theory, I suppose, that it is good for a young fellow to be "taken down," and made to feel that in this stage he is little better than a fool. I do not think this is right.

Another thing that we can do is to study our men, and select the more promising And we must not be too particular, either, in our choice I have seen some rather unpromising men turn out to be very successful botanists We must not turn men away simply because at first they do not seem to be promising Some slow men finally become good botanists and successful teachers On the other hand, I have known some brilliant men who in the end have done very little with all their brilliancy I feel sure that as teachers we should frankly tell our students what we think they are able to do Let us stop looking for Torreys, Grays, Farlows, Barneses, Coulters, etc That, however, is what we are doing We are putting up a standard that is only reached once in a long while Let us realize that the young fellows in our classes are very much as we were—just mediocre men Most of us are that, but we got on somehow,' and have been measurably successful And so will they Give them a chance

Then I fear that we have not treated botany as a profession, but merely as a subject of study Of course it is to be studied, and of course, also, it is to be taught But it is also a profession, and we should weave into our instruction much of the ethics of the science, whether it is to take the form of teaching or investigation The young botanist should be made to feel that he is going to *use* his botanical knowledge, and that he can do so with entire propriety Let us stop saying to the young man "You do not know enough yet to begin"—but let him begin!

Now, before I come to my closing discussion I want to make a slight digression in order to speak of college courses in general, and especially the go-as-you-please method to be found in most of our institutions I fully believe in having work prescribed as to kind and place in the college curriculum I believe in prescribing the

necessary language work early in the course. I believe also in prescribing the other science work. The old-fashioned classical courses, with some modifications admitting science, appear to me to be about the best foundation. You ask me why so? For the reason that they began at some place and ended at some place. There was consistency and continuity, with resultant training. The so-called "free elective" plan is to me the worst of all plans. The student is dazed by the many things that he can do, and he does not know what to do. In most institutions, he is supposed to have an adviser, but, as Abraham Flexner shrewdly says, "the advice is equivalent to perfunctory consent to propositions which the student himself submits." So the student generally ends by doing a lot of the easier things in a hodge-podge, aimless manner.

Now let me make a few suggestions with regard to the courses in botany. I fear that I may shock some of you by some things I am going to say.

In the University of Nebraska we are working on a three-year schedule (in a four-year college course) for undergraduate work in botany, intended to fit men for filling instructorships in botany. I do not believe in the "quick-meal" process in education, but as I look over what I have been doing the last forty or more years, it seems to me that we can concentrate our work to such an extent that a man who brings proper preparation otherwise to the work ought to be able, in three years, if properly guided, to complete the course. We are making this schedule aggregate from twenty to twenty-five hours only—not quite the equivalent of a single study taken three years. In this time we think it is possible to take a bright young man and fit him well to begin work. Of course he will not be the equal of our older men. Let us, however, give up the idea that we can turn out young men who know as much as Dr. Coulter or Dr. Farlow. That will take years, but a man can have a good preparation for teaching botany, as good as the young engineer gets—and he is ready for work when he finishes his course. So we are working on a three-year schedule and I think we are going to accomplish with it what has hitherto taken a much longer time.

We are proceeding with the following limitations. First. Such a three-year schedule must include a general survey of the plant kingdom.

Second. This three-year course must include the essentials of cytology and histology. It may not include an extensive knowledge of them, but their technique at least, and enough so that a man has mastered a few, at least, of the principles.

Third. Such a schedule must include the essentials of plant physiology.

Fourth. It must include also the essentials of taxonomy. I will not attempt to say how much that should be, and yet I am certain that there should be a considerable knowledge of taxonomy in regard to the plants that a man is likely to come in contact with. I should feel embarrassed if called upon to teach in a part of the world where I did not know what the plants around me were. I would not like to employ a man in my department who would frankly confess that he could not tell an ash tree from a maple.

These are some of the things that should be known. There are many things I have not included, but I think that what I have put into my schedule will fairly prepare a young man for beginning to teach. He can not take my classes, perhaps, nor Dr. Coulter's classes, but he can begin where we began in teaching, and *work up!*

Now this amount of botanical knowledge,

as I have mapped it out, is very much more than many of us had when we began It should fit a man for beginning to give instruction in the smaller colleges or in the minor positions in the universities It should fit him to lead intelligently the students that come to him in our normal schools I take it that it is in this direction that we must move if we are to be able to supply from our schools and our universities the men who are to follow us

You will notice that in all this I have said—"men" I have said so because I have found that when the demand comes, it is mostly for men I do not know why this is so We say very pretty things about our women students, and give them good high standings, and say complimentary things about them *as students*, and yet when you yourselves look around for some one to be an instructor, and we write and say—"there is a young woman here who will make a good instructor"—you say "Our present circumstances are such that we can not employ a woman" Here is one thing that we ought to change The supply of competent women is much larger than of competent men, and I can assure you from experience in my own department that they make admirable instructors

I have gone over this problem of the making of botanical teachers in this rapid way in order to stir up thought along many lines For I hold that it is a serious problem, and that we as teachers of botany owe it to the future that we should prepare in a proper way for the succession of teachers that must follow us

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II THE PRODUCT OF OUR BOTANICAL TEACHING

NOTWITHSTANDING the frequent assertion that teaching of botany is not what it should be, it seems safe to say that there was never a time when there was more good teaching of the subject than we have to-day That we should have dissatisfaction at a time when so much good teaching is being done, is not at all surprising, inconsistent or undesirable Botany itself has grown so rapidly, its call for new researches has been so insistent, its place in the applied sciences and in the affairs of men in general, has assumed such prominence and importance, its use as a means of giving a proper education in scientific thought about things that are worth knowing has been so vigorously claimed, that in consequence our attention is directed as never before to the possibilities and errors of botanical teaching

The teaching is not poorer—we merely know more about it Present practises are not wholly bad and need not be discontinued, but with the increasing richness and diversity of botanical knowledge, and with better definitions of the purpose of science education, particularly education by means of botanical science, we need to consider our practises anew If a prominent feature of reform is discontinuance of past vices, a feature of progress is discontinuance of past virtues for better and larger ones

If the product of our botanical teaching does not meet our ideals, we should look for explanation to some or all of the factors or causes of the very complex situation which confronts us

1 First, what are our ideals? What do we wish to accomplish through botanical teaching? Do we wish to use the study of botany as a means of developing on the part of the people in general a more dependable method of thinking, better reliance upon native powers of observation, experimentation and interpretation, an attitude that demands evidence before judg-

ment may be given, or do we wish to make knowledge of plant life, its structures, processes, habits and uses, the possession of the people in general in order that they may know more, enjoy more, or may more effectively adapt plant life to their economic uses? Do we wish to prepare students who shall take up research in botany to the end that unsolved problems may have solution? Or have we any definite purpose for botanical education other than that since botany is a field which we have found most interesting we wish to "pass it on" to others?

The ends which we seek certainly should receive the careful attention of all who are engaged in general botanical instruction. Research in botany is not the goal of general botanical education, and botany can not claim a place in the general curriculum of the high school or college if its primary aim is to prepare students for research in botany. On the other hand, research is perhaps the most important by-product of general botanical instruction, since when general courses of instruction are efficient there develop well-grounded students who desire to become investigators in the subject.

The purpose must be more serious than to give passing enjoyment, stimulate curiosity about plants, or to minister, as early botanists sometimes said, to the emotional nature of young ladies. There is great need of development of a rigorous scientific attitude toward plant phenomena. Plants and their products are our constant companions and there are certain fundamental facts and principles that people should know about them. If they learn these facts and principles in a way that develops care in observation, in experiment, and in proper thinking, I believe there is also secured enjoyment of plants and ability to make economic use of them. This central foundation in method and content should be best upon which to build research work. It would seem also that research would find a large number of worthy devotees if general courses of instruction were presented as broadly fundamental to the science, and more significant in practical affairs.

2. A second factor has to do with the quality and preparation of the students who present themselves in our college courses. From an amount of data too limited for final conclusion, it seems that most of the students who elect college courses in botany have had no botany in secondary schools. For some reasons, secondary school courses seldom lead students to take botany in college, or else college requirements prevent their doing so until they have become engrossed with other lines of work. Possibly the difficulty lies in inefficient courses or teaching in secondary schools. These courses have been accused of being too formal, too technical, too closely limited to a special field of botany, not sufficiently full of meaning to young students. Secondary courses in botany have also been accused of being too difficult—an accusation which I think is untrue. It is not, for example, the inherent difficulty of alternation of generations, but lack of any appreciable motive for studying it, which makes it seem difficult. The structure and workings of a steam engine or an automobile are more difficult, but they are "going things"—dynamic—and students solve their mysteries. If an appreciable motive is put into secondary teaching of botany its difficulties are solvable.

Possibly some of the difficulty lies in the fact that the different sciences are incoherent and intermittent in the high schools. In a valuable recent investigation made by an eastern biologist records were collected from 276 high schools. Botany is taught in 225 of them. It is distributed in the

different years of these high schools as follows first year 76, second year 94, third year 26, fourth year 29 It is evident in so far as these and other statistics go, that something in the way of definiteness is beginning to appear as to the year in which botany is taught But it is also to be noted that in these schools botany appears in almost every possible relation to the other sciences that are taught, and it is taught by teachers who teach almost every possible combination of subjects in the entire curriculum The sciences need more of the same sort of consecutiveness that is found in the languages, if we are to develop more worthy scientific value

Furthermore, from the above-mentioned investigation and others, it appears that the courses in botany vary in nature from systematic botany to a study of the anatomy and cytology which deal with plant evolution Surely the courses in secondary schools need scientific study, unless it is true that there is no part of the subject and no particular organization that is best for the education of beginners I believe we have a right to expect that a scientific organization of the science for the secondary schools, in addition to conferring better immediate results upon pupils, will lead more of the students who have done well in science to desire to continue these studies in college This would be of great advantage, for we need more students who early in life have begun to *think botany* and to think in the scientific method

The nature of the preparation of our graduate students is also a factor in our product This varies largely In at least some of the larger universities comparatively few of the graduates come from the local undergraduate body They have for the most part had their training in the smaller colleges, and those who come to the university are of two classes—those who are called, and those who are sent Some of them, through the more general courses of the smaller colleges, got their desire and enthusiasm for botanical investigation, and come to the university to continue that study They are chiefly those who give us new botanical knowledge Others, who have not secured suitable positions, come to the university and do graduate work as a means of securing better employment, and good botanists and good teachers sometimes develop from this group A compelling desire to study botany is the motive most likely to yield results of high order

3 Another factor in the efficiency of our student product is found in the nature and appropriateness of the courses into which these students go when they come to colleges Whether research or teaching is the end to be secured, there are needed courses in the general fundamentals of plant life and structures, and in chemistry, physics, physiography and general physiology Too early specialization is likely to produce a narrow research student, and to render a teacher unable to give to his students the necessary vitality in his introduction to general botany In our revolt from the special field of systematic botany, botanists went to an extreme of even greater specialization, so that sometimes students in research in morphology are uninformed regarding the relationships of the particular plants with which they work And so specialized are we at times that teachers in small colleges and secondary teachers who have had our so-called general courses must teach a special field of botany because they know no other It is quite possible in some cases to go into a secondary-school class in botany and by observation of the nature of the teacher's work, to determine the university in which the teacher was trained This, of course, is not an argument against research in which we all believe most pro-

foundly, nor against emphasis upon special lines of research in different universities, but is an argument against permitting that special research to dominate courses that presumably are for general education in botany As Schleiden in 1849 organized the general field of botany as an inductive science, we again need for general students a presentation of the fundamentals of the science as a whole

There are many other factors that have to do with the efficiency of the product of our botanical teaching We need more students who in their latter college years have definite purposes in mind—as teaching, research, practise of forestry, agriculture, etc Possibly our teaching ought to enable them to discover purposes that will absorb them as do other college interests

More fundamental, however, is the fact that we have been too content to assume without sufficient data, and to dictate regarding the nature of the needs of general instruction in our subject rather than to make the same sort of investigation in the field of teaching that we should make in our botanical investigation If we can devise methods of making a scientific study of botanical education, we can improve our student-product

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III METHODS OF BOTANICAL TEACHING

As a past master in the art of cooking botanical hares, Dr Bessey has spent most of his time in elaborating the recipe To me, however, the problem seems peculiarly one of making sure of getting the hare and then of keeping it long enough to cook it properly. As I see the problem, it seems almost imperative that the hare should be caught in the high school The chief difficulty in our getting material for turning into young botanists lies at this point. High-school students, and especially the boys, are not attracted to botany, one might say they are not attracted by the kind of botany offered More than that, and this may be the crux of the whole question, we fail signally to enlighten the parents of the boy as to the real meaning and place of botany Botany will not attract the attention of the high-school boy unless it meets every-day conditions—unless it puts him in touch with his every-day environment in a way that is sympathetic as well as illuminating Moreover, it is perhaps of equal importance to bring the public to understand what a fundamental place the knowledge of plants has in every-day life, and how important a part of education it is in consequence

So far as the high school is concerned, we have the situation entirely in our own hands Few of us can teach anything but what we have been taught, nor can most of us teach in any way but the one by which we have been taught If you will look over the high schools of your state you will see that the kind of botany you are teaching is the kind of botany that is being taught in your high schools. It seems to me that few botanists realize this fact It really means that we are actually teaching high-school botany to our beginners, for this is inevitably the botany that they will carry into the high schools When we appreciate this fact thoroughly, we shall change our elementary teaching When we do change it in a way to attract the sympathy of our students, then the problem of catching the hare, or at least of knowing the paths that he will follow, will be solved

The next most advantageous point for catching botanical hares is upon entrance to college This last year, in the University of Minnesota, the College of Arts graduated 265 bachelors—most of them maids. There were 195 of the latter and only 70

men Out of the 265, thirty-five had taken a major in science, for many of the thirty-five, this meant but three courses in science during the whole college course This tells definitely, it seems to me, of our failure to attract freshmen to science This failure is largely our own fault It is the failure of botany to provide a definite avenue to a position, such as is offered by courses in law, medicine, engineering, agriculture and forestry The boy does not enter botany, because he knows of no such opportunity in it There is no definite course set forth in the catalogue for the training of professional botanists, such as we find everywhere in colleges of agriculture, engineering, etc

Our second failure, and the most significant one, it seems to me, is to hold our hare long enough to make a plausible instructor of him—to make even the beginner that Dr Bessey has in mind, one who knows enough to find out what he must do to learn how to bud pecan trees It seems to me the signal failure we are all guilty of in teaching elementary botany is the failure to catch the students' point of view—of realizing that it is what the student needs and likes in his own peculiar environment that must determine, the method of teaching and the matter that we use I can not see that the materials for our courses should be assembled, as they have been, from the standpoint of the professor, upon the obvious assumption that what the professor likes to teach the student is the best thing for him to learn This seems to me the chief reason why we fail to hold students in any considerable number for advanced work Naturally, this does not apply to the two or three universities which attract students from all over the country for graduate work It concerns the majority of botanical departments, however, in which the hope of advanced students must be realized chiefly from the beginning classes

To become concrete, it would seem that the microscope is responsible to a very large measure for our difficulty No hard-headed boy of freshmen age expects to carry a microscope around in his pocket throughout his life He is interested in things that go and things that work, and I believe that we shall get his sympathy and interest and succeed in holding him for advanced work only as we give him what he wants and needs in this respect Last year a freshman girl opened our eyes somewhat more widely on this very point She was working with the germination of seeds in the greenhouse, after describing the steps in germination, she added naively as an afterthought, "the seeds we worked with were real peas such as you see on the table" The microscope has made the student feel that he is dealing with an unreal world, and that the plants we use in botany are none of them of the least importance in every-day life Not only is the microscope far too special an instrument for the beginner, but this specialized tendency also permeates nearly all elementary botanical teaching I recently encountered a sentence which will illustrate this fact It is taken from a book which "is addressed to pupils in their first or second year in the high school" The sentence is the following

> The change from free parts of hypogynous flowers to union of parts as shown in perigynous, epigynous, epipetalous, sympetalous and synsepalous flowers, reaching the climax in the composites

I find it difficult enough to get such ideas into the heads of college sophomores, with any real understanding of their meaning In the case of high-school students, it indicates clearly that we are shooting far over their heads While I admit that a good drill-master can make a student memorize

a statement like this, I feel that it is practically impossible to give him any real understanding of the many concepts in it, in any beginning course We succeed in making our beginners feel, as a consequence, that botany is nothing but a lot of long hard names

Now what is the remedy for the dearth of advanced students? In the first place, I recognize fully that we will hold students for advanced work only as we gain their interest and sympathy in the general courses The test of our general courses in college botany must be—what does the student need, and what must he use in everyday life To many of you this practical outlook upon the subject seems to be in conflict with what we call a scientific presentation To me, scientific botany means presenting the important facts about plants from the standpoint of their everyday behavior and use, in a thorough, accurate and systematic fashion While it is a time-worn truism to say that we must proceed from the known to the unknown, yet we must realize that no one ever succeeded in learning in any other manner We must take the student in his every-day plant environment, set him to work puzzling about it, and point out the way by which he can solve his own puzzles I think it is as unfortunate as it is illogical, that our education should be built upon the assumption that the early years are for memorizing, and the later years for reasoning Until parents and teachers have stifled the spirit of curiosity, which is only the research spirit in an earlier form, the child is constantly reaching out for new experiences, asking endless questions, and taking endless clocks and dolls to pieces I will admit that this spirit of inquiry has almost disappeared by the time the student enters college, but it can be fanned into an active flame again in many cases Still more important than this, however, is to find a way to keep it alive

For the most practical of all remedies, we must give our attention to the difficulties arising out of the fact that the school year runs the wrong way around If the student is to deal with live plants, with plants as agents and materials in every-day life, as he must to be interested and benefited, we must realize that these things can be obtained only by the most careful planning We must not only find means for stretching the plant season at both ends, in the spring and in the fall, but much more important still, we must confront the fact that beginning botany can not be properly taught without adequate greenhouses, as well as gardens The greenhouse means constant contact with the most interesting and the most useful plants throughout the whole school year It lends itself readily to the task of bringing the student into touch with the uses and applications of plants in a natural way Indeed, the most indispensable feature of real botanical study, that of independent first-hand work with the living plant, is hardly possible without adequate greenhouses The every-day relations between man and plants are of vastly more importance than all of the other things that we teach under the name of botany They will not only crowd to overflowing the two years of beginning botany, but they will fill up a large part of the advanced courses

One of our most signal failures arises from our feeling that a record in the form of drawings or notes constitutes knowledge—that the record indicates that the student really understands what he is recording Nothing is further from the truth, as a rule The record has no value, indeed, it rather does harm, except to indicate to what extent the beginner observes correctly and thoroughly As something to be

crammed for quiz or examination, it is downright pernicious, hence the formal record should be reduced to a minimum, and the real emphasis laid upon first-hand contact with live plants, correct and thorough observation, and independent reasoning

Again, as botanists familiar with an enormous amount of detail, we try to make the college course in botany cover just as many things as possible One can admit that it should do this in so far as it can, and still realize that it can do this in only a small degree Nearly every course, and every text-book without exception, contains several times as much matter as the student can assimilate Indeed, if we remember that we ourselves learn little except by experience and experiment, we shall see that this must apply much more forcibly to beginners in botany For this reason I do not believe in text-books, or in lectures in any general course whatsoever, I would have none of them This no longer seems to be a mere opinion, but the logical conclusion from actual and definite experiments in teaching botany Listening to talks about plants can not lead to real learning in any sense of the word, and reading about them is in some respects worse rather than better, so far as the beginner is concerned

I would replace text-book and lecture wholly by first-hand contact with plants I would do away with all set quizzes and examinations, and make the student face the test of his work just as often as he faces the work itself Moreover, even by this method, students can learn little by single contact To take up a plant or a function or a structure once, and then to leave it, not only wastes time, but it also fixes an unfortunate habit A tandem arrangement of materials and courses can never give the beginner real understanding Every course should telescope the one before it, touching the major points again and from different angles, broadening and deepening the student's knowledge upon a sure foundation, not upon the mere assumption that he recalls or understands anything that he has had

To some teachers the universal remedy for lack of knowledge or understanding on the part of the student is what is called the intensive course The latter has certain apparent advantages One covers more ground, without question, and the student's handling of the subject matter seems a little more certain The real test of an intensive course, however, can be made only by unexpected quizzes at intervals of a month or two after the course has been completed Any one who applies such a test to an intensive course will need no further argument in regard to it One who has applied such a test can not feel like giving any more time to discussing its value

I wish to emphasize the point Dr Bessey has made as to the need of using young botanists just as early as possible We are now trying out a plan by which sophomores, who plan to specialize in the subject, are put in charge of small groups of freshmen in greenhouse work The plan during the first year has proved much more successful than we anticipated, and it will be extended just as rapidly as possible It has been a splendid thing for the sophomores, and it has not proved fatal to the freshmen

I can not close without pleading that we make the teaching of botany a matter of experiment We should be ecologists who study the student, the method, the matter and the results, both as to knowledge and to training, in an exact, quantitative manner If we do this, we shall get rid of our loose opinions that for the beginner in bot-

any any method is as good as any other method, and that the results must be good because *we* have done the work I feel sure that the use of experiment in connection with our methods of teaching, and the measurement of results will go a long way toward changing our present methods and improving upon our present results

F E CLEMENTS

UNIVERSITY OF MINNESOTA

DISCUSSION

Professor John M Coulter, University of Chicago

As Dr Bessey says, some of us began botany a good while ago, when facts were so few that they were pieced out with enthusiasm, and our knowledge of the subject was chiefly enthusiasm, but now the facts have multiplied so enormously that it is a problem how to present them

I have been in discussions of this kind for a good many more years than I should like to acknowledge They have all sounded alike to me, but the thing I learn from them is this that no matter how much thought we give to the technique of teaching botany, or how many devices we suggest as to methods of presenting it, a gratifying group of successful botanists continue to surmount all the obstructions we manage to place in their way My definition of a successful teacher has long been one who places the fewest obstructions in the way of the student

It is clear that we must encourage independence and originality in our students if they are to become investigators or only teachers This attitude is appearing in the teaching of botany, for teachers are becoming more independent, and are thinking more for themselves No teacher, however successful, has the right to prescribe for others a detailed method of teaching It is only a stupid teacher who copies some other teacher Every one must have his own way, and if the text-book is the only way for him, let him use it, if he can do better without it, let him throw it away

In brief, the problem is this We are confronted by all sorts of suggestions as to teaching Our subject has grown to be so vast and is still growing so rapidly that we know not how to deal with it in detail There are just two general things that a teacher must keep in mind, and the details can be left to shift for themselves

In the first place, there must be developed a general perspective of the subject It is a vast plexus, and each of us in his own individual way must develop for the student some conception of the extent and interrelationships of this plexus we call botany, so that he may leave us with no narrow vision

In the second place, in addition to the perspective, there must be developed what we call the scientific method, which is a certain attitude of mind This is absolutely fundamental There are many ways of doing this and every teacher has his own way of enforcing the training that demands the truth, and knows what it takes to reach the truth

It is my conviction that any one cultivating this perspective and this scientific attitude of mind, by whatever detail of method they have been reached, is likely to prove successful in any form of botanical activity, whether it be teaching or investigating, with the scientific motive or with the practical motive The details have become too numerous to include in instruction, but it will always be possible to train a spirit that will be able to master any details

Professor F C Newcombe, University of Michigan

I will say that I feel considerably cheered up since the last two addresses No doubt

the rest of you, or some of you, feel the same way I was beginning, a few minutes ago, to congratulate myself that such instruction as I had received was received twenty-five years ago instead of at the present time, because I know that if it had been received at the present time I could have become nothing but some poor ignoramus

First of all, I should like to refer to some of the ideas presented here this evening

Professor Bessey stated that our students in the university are looking here and there without reference to any aim in life, and I wondered whether he had actually looked into the matter of student elections in his university, where elections have been quite free, as they are in the university with which I am connected, or whether he has been seriously investigating this subject The matter has been looked into in my university, and there it is found that more than 80 per cent of the students who have perfect freedom in elections have elected with some aim There is a comparatively small percentage of students who are browsing around without taking any direction

The second thing that Dr Bessey says is that he is trying a system of instruction in his university of 20 to 25 hours in botany as preparation for a college or university instructorship That is the minimum we in Michigan think the average student should have for preparation to teach botany in the high school

It was said a few minutes ago by Dr Coulter that it is not a matter of the number of hours the student spends on a subject, but it is the ability which the student develops for doing things, his attitude, his efficiency, his originality, that makes him able to advance I had some years ago a student who took only one year in botany. She was a teacher, and she had been teaching for some time, and I gave that woman the strongest recommendation of any woman who went out that year She had only one year, and yet she was ready It is not how many courses the student has, it is a matter of the student's ability to take new ground, to start in a new direction and develop the subject for himself

On the side of research I can not help placing in contrast to the quantity of preparatory work which some of us think we must have from our students before coming to research, that well-tried system in the German universities with which you are all familiar, and which reduces the number of students to a few successful ones by the law of survival of the fittest You know that, in the German universities, the student takes perhaps on the average not more than one year in elementary botany, and is then allowed to go along for a few weeks, or possibly a semester with a *Vorarbeit*, and is then thrown mostly upon his own resources for investigation There are many successful botany teachers and investigators who come out of that sort of training. I wouldn't advocate that sort of training in this country, but I think there is danger of our overdoing the matter in endeavoring to give the student something of all kinds of knowledge in botany If the student is fit for any kind of teaching after he has had proper training in some lines of work he will be able to work out something for himself that he may not have been trained for in the schools

It was stated here also in one of the addresses that the aim of general education is not for research I think that statement was made I would not say that one aim of general botanical education is not for research What have we been talking about and hearing about in this session of scientific societies in Minneapolis? We have been hearing of the need of the in-

vestigation of plant physiology, of phytopathology, of the study of all things that are related to the welfare of the people of this nation and of the world. Now, if it isn't the university's business to prepare men for research, I should like to know where that business does lie.

It seems to me we have a double duty—we must provide teachers and we must provide investigators. The university's function is just as much for research as for instruction. The staff should be just as much bound to the doing of research as to the giving of instruction, and just as much bound to train the young people under them for research as to train them for teaching. We need both. We need research just as much as instruction.

Now, is it true, as was stated here, that there is no open door to a career in the study of botany? It was said of law, medicine, etc., that there is an open door. But at the present time we can say to the student, there is also an open door in the study of botany. What does it mean when Dr. Bessey says they can not supply the demand? We have all of us felt that same thing. It means that, although the remuneration is not adequate in many directions, still there is the open door toward the earning of one's livelihood at least.

Now, to take up quite a different matter, and that on the main subject that this discussion opened with; that is, the question as to why we do not have more students becoming professional botanists. That's what the meaning is, I think, of the question as it was put. Now, the case is not so bad as has been presented here. If you will pardon me, I will review the relations at our own institution. We have no agricultural college at the university. We have a first-year class of 200 students—I think 194 this year; we have, besides that, in our classes above the freshman year, 175 students. Now, that proportion does not seem to me to be bad at all. We have our advanced classes with ten students, fifteen students, one class with thirty-two students, another one, second-year students, or mostly of second-year students, with fifty-five, and to my mind the proportion is not bad and it does not call for any great alarm as to the future. I expect in the future that the proportion of students in the advanced class will tend to increase instead of diminish. I don't see why it should not.

I find the method of encouraging the promising student to go on with the work is justified. We all make mistakes, but nevertheless we can, with ordinary good judgment, read the case right four times out of five, and perhaps more often than that, and I have found that by advising with those who attract attention as capable students, one can usually find several who can be led, without very much persuasion, in the direction of becoming professional botanists. One thought that is on a different matter. I have been considering for two or three years whether, as teachers of high-school teachers, we ought not to change somewhat—I know it is already done in Minnesota—whether some of us ought not to change our methods so that the perspective of the high-school teacher is brought more into relation with his subject matter as it occurs in nature. Of course, a great deal can be done by greenhouse study, but after all that does not take altogether the place of field study, and I believe we must draw these teachers to field study so that when they go out to teach botany in the schools they may show their pupils the way by which they can in themselves carry the work further than it is carried in the schools—the high schools and lower grades.

I would like to see a set of statistics from

which I could ascertain how many of the professional botanists—those who have passed out from under our hands within the past ten or fifteen or twenty years, or longer—how many of these were young investigators before they went to the high school I will venture to guess that I could pick out in this room fifteen or twenty of the men who sit right here whose youth I know something about, who made collections of plants and insects and hammered up rocks to get the fossil shells out of them before they went to the university or came within three or four years of it

If statistics should bear out my belief, we should find that most scientists are so born and not given their bent by training, and that the few turned by training in the direction of professional science are thus influenced by the teacher who knows how to make the student an investigator at the same time he is pupil

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LEONARD P KINNICUTT

IN the issue of SCIENCE of February 17 there appeared a brief notice of the death of Professor L P Kinnicutt, director of the department of chemistry in the Worcester Polytechnic Institute

Leonard Parker Kinnicutt was born in Worcester, May 22, 1854, the son of Francis H and Elizabeth Waldo (Parker) Kinnicutt He received his early education in the schools of Worcester, graduating from the high school in 1871 He went at once to the Massachusetts Institute of Technology, where he devoted himself chiefly to the study of chemistry. Following his graduation, in 1875, with the degree of bachelor of science, he spent four years in professional studies in Germany At Heidelberg he came under the inspiring influence of Bunsen from whom he acquired an appreciation of the value of careful and accurate analysis Here also under Bunsen's guidance he was initiated into the refinements of gas analysis. This was the period when organic chemistry was developing with tremendous rapidity especially in Germany. Bunsen had passed the zenith of his career and was not in sympathy with the new tendency which was manifesting itself in chemistry It is not surprising then to find the young Kinnicutt leaving Heidelberg and matriculating at Bonn Only ten years before, Kekulé had been called to the University of Bonn to take charge of the newly built laboratory, which at that time was the finest in all Germany and after which later laboratories were patterned Kekulé's was a charming personality His lectures were a model for simplicity of arrangement and clearness of presentation, and the experimental demonstrations were carried out with such fascinating ease and dexterity that the young Kinnicutt was captivated by the spirit and beauty of organic chemistry and devoted himself diligently to its study

He was fortunate in being accepted into the private laboratory of the master, where he became associated with Richard Anschutz, the present director of the Chemical Institute at Bonn In collaboration with Anschutz he published a number of papers, chiefly on phenyl-glyceric acid This association ripened into a lasting friendship Returning to the United States in 1879, he spent a year in study with Ira Remsen at the Johns Hopkins University, and then three years at Harvard, where he served as instructor in quantitative analysis and as private assistant to Wolcott Gibbs, at that time Rumford professor of chemistry In 1882 he received from Harvard the degree of doctor of science and in September of the same year accepted an appointment as instructor of organic chemistry at the Worcester Polytechnic Institute In the following January he became assistant professor of chemistry, three years later he was made full professor, and since 1892 has been director of the chemical department.

As early as 1885 Professor Kinnicutt began to give attention to the question of sewage disposal and sanitary problems. He became an authority on the sanitation of air, water and gas, on the methods of analysis and on the disposal of wastes He paid particular atten-

tion to the examination of water and watersheds and the contamination of rivers and ponds by trade wastes and sewage He made numerous reports, both as regards private and public water supplies

He visited England on an average every other year since 1894, familiarizing himself with the work done in that country and the results were embodied in various articles which he published on the subject He paid special attention to the subject of the pollution of streams by wool-washings, and made a careful study of this problem at Bradford, England, where a greater amount of wool is washed annually than in any other city in England or in this country

He was employed as an expert in numerous cases regarding the pollution of streams and ponds, and was one of the experts in the case of the pollution of the Mississippi River at St Louis by the sewage of Chicago In 1903 he was appointed consulting chemist of the Connecticut Sewage Commission, a position which he retained up to the time of his death He was a frequent contributor to scientific periodicals and the proceedings of learned societies upon topics relating to his specialty

In 1910, in collaboration with Professor C E A Winslow, of the Massachusetts Institute of Technology, and Mr R Winthrop Pratt, of the Ohio State Board of Health, he published a book entitled "Sewage Disposal" which is considered to be one of the best treatises on the subject of sewage disposal in the English language

Professor Kinnicutt's reputation was not confined to this country He enjoyed a wide acquaintance, both in England and on the continent, and possessed the rare faculty of keeping ever fresh and active a friendship once established One of his highest honors was the appointment as president of the Section of Hygiene of the International Congress of Applied Chemistry, which is to be held in Washington and New York in September, 1912 Even to within a few days of his death he continued to work with characteristic zeal in perfecting plans for the success of the section over which he was to preside Professor Kinnicutt was deeply interested in the sanitary problems of his native city, Worcester. He kept a careful watch upon the city's water supply During the "water famine" of the present winter, from his sick-bed he directed the tests to be made, had daily reports brought to him and outlined the policy by which, in his opinion, the city's health might be best safeguarded

He devoted a great deal of time and money to secure a pure milk supply in summer for the babies in needy families, and at the time of his death he was a member of the Worcester Medical Milk Commission, which is investigating the question of pure milk for the city Professor Kinnicutt was widely connected with scientific associations, he was a fellow of the American Academy of Arts and Sciences, a fellow of the American Association for the Advancement of Science, of which he was vice-president in 1904, a member of the American Chemical Society, and president of its Northeastern Section in 1902, and councillor for a succession of years, a member of the Society of Bacteriology, a fellow of the New England Water Works Association, of the Boston Society of Civil Engineers; of the American Antiquarian Society, and of various foreign associations, including the Association of Managers of Sewage Disposal Works of England, the London Chemical Society, and the German Chemical Society He was a member of several social clubs in Worcester and Boston and retained to a remarkable degree his interest in the alumni reunions of the Massachusetts Institute of Technology, of the Johns Hopkins University and of Harvard University, and he rarely failed to be present and add his geniality to the general good cheer.

Esteemed and honored by the scientific world, and beloved by a wide circle of acquaintances, yet it was as a teacher that the true worth of his character manifested itself Possessed of a broad training and knowledge of his subject, and a fund of personal experiences, with which he punctuated his lectures, he was enabled to drive home the truths which he desired to impress on the minds of his stu-

dents. Interest in his students, however, did not cease with the lecture or the laboratory. He was ever ready to listen sympathizingly and indulgently to those students who were in distress, and to all such he gave liberally of his time and purse. This conscientious devotion to duty and unselfish human interest endeared him to the students and alumni. It came as a great shock to all when, after a delightful summer of European travel and the resumption of his academic duties, apparently in his usual good health, he was attacked by a slow fever which confined him to the house after but a few days of activity. The trouble was diagnosed finally as tuberculosis. He received his first warning that he had this insidious disease in his system when he was a student in Germany, but had apparently fully recovered from this earlier attack. It was hoped that a year's leave of absence and careful nursing would restore him to health and the resumption of a part at least of his former activities. Toward the end of January, however, his heart became seriously affected, and he failed rapidly until the end came peacefully on the morning of the sixth of February.

Professor William T. Sedgwick, a lifelong friend and one of the pallbearers at his funeral, paid a fitting tribute to his memory when he said, "His was a unique, lovable and altogether charming personality. Kindness and friendship such as his life exemplified could no further go. He was critical, yet just, fearless yet considerate of others, honest to a fault, a hard worker, and to a degree nowadays unusual, an accomplished and cultivated gentleman."

W. L. Jennings
Worcester Polytechnic Institute

HENRY PICKERING BOWDITCH

The following memorial note on the life and services of Professor Henry P. Bowditch has been prepared for the American Physiological Society by a committee of its members.

At the death of Henry Pickering Bowditch there passed away a man who had notable influence on the development of medical and biological science in America. He was born in Boston, April 4, 1840, and was graduated from Harvard College in 1861. As a graduate he began the study of chemistry in the Lawrence Scientific School, but left, in November, 1861, to become second lieutenant in the First Massachusetts Cavalry, then starting for the front. After loyal and chivalrous service to his country during the remaining three and a half years of the Civil War, he resumed his studies in Harvard University and received, in 1868, the degree of Doctor of Medicine. Thereupon he went to France and Germany to learn from the masters of his chosen science, physiology, the aims and methods of research. Filled with the spirit of Bernard and Ludwig, he returned to the Harvard Medical School in 1871, and established the first American physiological laboratory for the use of students, a laboratory which soon proved hospitable to investigators in every phase of experimental medicine. For thirty-five years he was an energetic and inspiring teacher, and a leader in investigation. His studies of the peculiar functions of cardiac muscle, the indefatigability of nerves, the knee-jerk and conditions affecting it, the force of ciliary activity, and the growth of children, illustrate the range and originality of his researches. Apparatus invented by him and widely used in physiological laboratories attest his mechanical ingenuity. He was one of the founders of the American Physiological Society and was its second president. The traditions of the society, particularly its character as an association to encourage research, are largely the result of his initiative. His example and his genuine appreciation of new work as it was reported at meetings of the society were a wholesome stimulus to young men beginning physiological investigation.

To the larger interests of medicine he rendered important service by promoting reforms in medical education, notably by advocating and helping to introduce the four years' required course, and later by strongly urging greater freedom of election in medical study. The Harvard Medical School he served as Dean for a decade of important growth, and the development of the school will long con-

tinue in directions which his wisdom foresaw Among the most valuable of his activities was his repeated defense of animal experimentation against unreasonable legislative restrictions, an activity in which he secured victories likely to preserve freedom of medical research for many years to come

The honors received by Dr Bowditch were many He was a member of numerous learned societies in this country and abroad He was a doctor of science at the University of Cambridge, and a doctor of laws at Edinburgh, Toronto, Pennsylvania and Harvard In 1900 he was president of the Triennial Congress of American Physicians and Surgeons

With sure and sober judgment Dr Bowditch combined vigor and readiness of action which made him a natural leader He was a neverfailing source of stimulation and encouragement to all progressive movements aimed at professional and civic improvement, and his mind was fertile with ingenious and effective ways to secure the accomplishment of worthy ends These qualities of leadership were combined with other qualities--keen interest, unfailing courtesy, fairness and good will--that won for him not only the friendship and lifelong devotion of the foremost men of medical science in this country and abroad, but also the affection of his students and close associates From the days of his youth, when he began the struggle for ideals, to his last years of failing strength, he met what life brought him with courage and cheerful humor, and he passed away as much loved for the beauty and strength of his character, as he was admired for his achievements

S Weir Mitchell,
Russell H. Chittenden,
William H Howell,
Walter B Cannon

THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

The council met at the Cosmos Club, Washington, D C, on Tuesday, April 18, 1911, at 5 P M

Mr Minot reported the following from the Committee on Policy

1 To recommend to the council that it look with favor upon the holding of a Pacific Coast meeting in the summer of 1915 and of extending this meeting to the Hawaiian and the Philippine Islands

2 To recommend to the council that it (the council) recommend to the next general committee that the meeting of 1913–14 be held at Atlanta, Ga, postponing the proposed meeting at Toronto until a later year

The council adopted the above resolutions

The secretary of Section I reported nominations of officers for that section as follows

Vice president and Chairman—Oscar P Austin
Secretary—Seymour C Loomis

These nominees were elected

On motion by Mr Cattell, the permanent secretary was instructed to inform the officers of the societies usually meeting with the American Economic Association that the American Association would view with pleasure closer relations between this association and these societies and would be glad to have them represented upon our council

The permanent secretary made announcement as to the preliminary work which has been accomplished so far by the local executive committee for the Washington Meeting

It was suggested that it would be advisable to instruct the secretaries of the sections, prior to the long vacation, concerning the general interest sessions

Messrs Minot and Welch were appointed as a committee of the council to ask President Taft for some official recognition of the coming Washington meeting

SCIENTIFIC NOTES AND NEWS

At the meeting of the National Academy of Sciences on April 20, the following were elected to membership Edward Emerson Barnard, astronomer, Yerkes Observatory, Williams Bay, Wis, Edward Burr Van Vleck, professor of mathematics, University of Wisconsin, John Fillmore Hayford, director of the College of Engineering, Northwestern University, Edwin Herbert Hall, professor of physics, Harvard University, Julius Oscar Stieglitz, professor of chemistry, University of Chicago, Bertram Borden Boltwood, pro-

fessor of radio-chemistry, Yale University, James Furman Kemp, professor of geology, Columbia University, Arthur Louis Day, director of the Geophysical Laboratory of the Carnegie Institution, Robert Almer Harper, professor of botany at the University of Wisconsin Foreign associates were elected as follows Professor Ernest Rutherford University of Manchester, England, Professor Vito Volterra, University of Rome, Italy At the annual dinner of the academy on April 10 the Draper Gold Medal was presented to Mr C G Abbot, of the Smithsonian Institution, for his researches on the infra-red region of the solar spectrum and his accurate measurements, by improved devices, of the solar "constant" of radiation

DR ALEŠ HRDLIČKA, of the U S National Museum, has been made a corresponding member of the Société des Americanistes de Paris, and a foreign associate of the Società Italiana d'Antropologia

DR J S FLETT has been appointed to succeed Dr J. Horne, F R S, as assistant in Scotland to the director of the Geological Survey

MR FRANK M CHAPMAN, of the American Museum of Natural History, has sailed from New York for Colombia, South America, where he is to join Mr William B Richardson, who has been in that locality collecting birds and mammals for the museum for several months Mr Chapman expects to get into a region where no collecting of birds has been done, there he will make a systematic survey, probably obtaining some undescribed species and many new to the museum collections He will also get material for several new bird groups He has taken an assistant and expects to remain until July, when Mr Richardson and the assistant will continue the work

DR ELLSWORTH HUNTINGTON, of the geographical department of Yale University, is at present making explorations in New Mexico Mr Huntington is making his headquarters temporarily at Sante Fé in the old governor's palace, now used as the Museum of the Archeological Institute of America The field of exploration will cover the old Pueblo ruins and cliff dwellings

MR W A ORTON, pathologist in the Bureau of Plant Industry, Washington, sailed on April 22 for Hamburg, and will spend six months in the study of plant diseases and the sugar beet industry in Germany, Austria, Russia, France and England He will attend the fourth International Conference on Genetics at Paris and present a paper entitled "The Development of Disease-resistant Varieties of Plants"

DR YANDELL HENDERSON, of Yale University, is to make, during the coming summer in company with Drs Haldane and Douglas, of Oxford University, an extensive exploration around Pikes Peak, for the purpose of studying the effects of high altitudes on men and animals

PROFESSOR EDUARD SELER, of Berlin, on leave of absence in Mexico, has discovered a set of ancient paintings on the walls of one of the apartments of the Palenque Palace

THE Prince of Monaco has appointed as members of the first council of the new Institute of Human Paleontology in Paris MM Salomon Reinach, Boule, Berneau, Cartailhac, Capitan, Villeneuve, for France, Sir Ray Lankester for the British Isles, Professor von Luschan for Germany, Professor Hoernes for Austria-Hungary, Professor Issel for Italy, and Professor G Retzius for the Scandinavian countries

DR A E KENNELLY, of Harvard University, has accepted an invitation from the University of London to deliver a short series of lectures in London, at the end of May next, on "The Application of Hyperbolic Functions to Electrical Engineering Problems"

PROFESSOR FRANCIS E LLOYD, of the Alabama Polytechnic Institute, has recently lectured before the staff and students of the departments of botany and zoology of the Johns Hopkins University, on "The Behavior of Tannin in Persimmons during Ripening"

ON the evening of April 10, Dr. Wallace W. Atwood, of the University of Chicago, gave an illustrated lecture before the Geographic So-

ciety of Chicago on the "Mesa Verde National Park." It was a geographic study of the home of the cliff dwellers.

A recent meeting of the New York Academy of Medicine was devoted to addresses commemorative of the life and work of Dr. Edward G. Janeway. Dr. Francis Delafield spoke of him as the "Physician", Dr. William H. Welch as the "Pathologist", Dr. Abraham Jacobi as the "Consultant," and Dr. Joseph D. Bryant as the "Colleague and Friend."

At the coming meeting of the Medical and Chirurgical Faculty of Maryland, portraits will be presented of the late Dr. Francis Donaldson by Dr. William H. Welch and of Dr. Charles M. Ellis, Elkton, by Dr. Lewellys F. Barker.

English journals announce the death of Mr. Charles du Bois Larbalestier, a leading authority on lichens, to whom the last edition of Leighton's "Lichen Flora" was dedicated, and of Mr. J. S. Slater, for many years principal of the Civil Engineering College, Sibpur, near Calcutta.

The United States Civil Service Commission announces an examination to fill four vacancies in the position of forest pathologist in the office of Investigations in Forest Pathology, Bureau of Plant Industry, Department of Agriculture, at a salary of $1,800 to $2,400 per annum. It is expected that the persons appointed to these positions will be assigned for the greater part of the time to duty outside Washington, in charge of branch offices. Applicants will be required to show that they have had a broad scientific training, as well as considerable successful experience in technical or executive capacities. It is also desirable that they have training in plant pathology and botany equivalent to that required for the Ph.D. degree. The examination is open only to men, and competitors are not required to appear at any place for examination.

Beginning on July 5 and continuing during the months of July and August, the facilities of the Seed Laboratory of the Bureau of Plant Industry, U. S. Department of Agriculture, Washington, D. C., will be available, as far as space permits to any one wishing to become familiar with the practical methods of seed testing. There will be an opportunity to observe the laboratory methods of testing for germination and mechanical purity, including the recognition of crop seeds and the commoner weed seeds.

The *British Medical Journal* states that the first meeting of the International Committee of the seventeenth International Medical Congress would be held in London on April 21 and 22. The president of the committee is Dr. Pavy, the general secretary, Dr. Burger, of Amsterdam, and the members are Professors Waldeyer and Posner, representing Germany, Genaro Sisto, Argentina; von Eiselsberg, Austria, Déjace, Belgium, Rousseff, Bulgaria, Rovsing, Denmark, Ruffer, Egypt, Recasens, Spain, Musser, United States, Blondel, France, Kalliontzis, Greece, Koloman Muller, Hungary, Maragliano, Italy, Kitasato, Japan, Fonck, Luxemburg, Uchermann, Norway, Pel, the Netherlands, de Mattos, Portugal, von Ott, Russia, Subbotic, Servia, Henschel, Sweden, Cérenville, Switzerland. In addition to these, the following are members of the committee: Dr. von Grosz of Budapest, as general secretary of the previous congress, Sir Thomas Barlow and Dr. W. P. Herringham, of London, as president and general secretary respectively of the forthcoming congress, and Dr. Lucas-Championnière, of Paris, as president of the International Medical Press Association. The committee will have brought before it for approval the resolutions passed by sections of the sixteenth congress. It will also consider the date of the eighteenth congress, arrange the number and nature of the sections, and discuss a general regulation as to the organization of the congress and its position in regard to international specialist and national congresses. In this connection the general secretary of the committee, Professor Burger, will present a report on a series of proposals made by Professors Waldeyer and Posner. We understand that a proposition will be made to the com-

mittee that the date of the congress shall be changed from July 29 to August 6, as previously fixed, to August 4 to 9, 1913

THE local committee of the American Society of Mechanical Engineers, E M Herr, chairman, Elmer K Hiles, secretary, having in charge the preparations for the convention of the society, which will be held in Pittsburgh, Pa., from May 30 to June 2, inclusive, has nearly completed the work of arranging the program for each day during the meeting It has been settled that the arriving guests will be received and registered at the Hotel Schenley, the society headquarters, on Tuesday morning, May 30 In the evening there will be an informal reception for the members and ladies in the parlors of the hotel The extensive alterations being made by the new management of the hotel will add very largely to the comfort and enjoyment of visitors during the convention The professional sessions will be held in the lecture hall of the Carnegie Institute, near the headquarters, Wednesday morning and evening, Thursday and Friday morning In the meantime there will be a number of inspection trips to various industrial plants in the vicinity, a boat excursion for the members and ladies up the Monongahela River, a reception and ball at the Hotel Schenley on Thursday evening and, finally, on Friday evening, a smoker and entertainment, given by the Engineers' Society of Western Pennsylvania in their rooms in the Oliver Building A carefully prepared program for the entertainment of the lady visitors has been arranged by a committee of ladies from Pittsburgh and vicinity, which includes a number of social functions Judging from the number of inquiries, which have already been received from expected guests, a very large attendance is looked for, and everything indicates that this meeting in Pittsburgh will be one of the most successful "spring meetings" the society has ever held

THE twenty-second season of the Biological Laboratory of the Brooklyn Institute of Arts and Sciences will be held at Cold Harbor, Long Island, from June to September The regular class work will begin July first and continue for six weeks The courses offered include field zoology by Dr. H. E Walter, Dr C B Davenport and Mr. Sidney I Kornhauser, bird study by Mrs Alice Hall Walter and Mr G Clyde Fisher, comparative anatomy by Professor H S Pratt and Dr A A. Schaeffer, general embryology and microscopic technique by Miss Mabel Bishop, cryptogamic botany by Professor D. S Johnson and Mr H H York, plant ecology by Professor Henry S. Conard and Miss Ruth Higley, beginning investigation in animal bionomics, evolution, cryptogamic botany and ecology by instructors in those subjects A training course for field workers in eugenics is offered Twenty scholarships are available for properly qualified college graduates with biological training who wish to prepare for positions as field workers in connection with institutions and hospitals About two thirds of those receiving scholarships may look for appointments in such investigation A biological club meets two or three times a week during the evening One scholarship of a hundred dollars is available The announcement of the laboratory may be obtained by writing to the director, Dr C B Davenport, at Cold Spring Harbor, Long Island, N Y

ON April 11 Governor Tener sent a special message to the Pennsylvania legislature, recommending immediate legislation for control of the bark disease of the chestnut A bill has since been reported providing for a commission to undertake this work, and carrying a total appropriation of $285,000 So far it is only the eastern and southeastern counties of Pennsylvania that are completely infected with this disease, and it is hoped, by the elimination of spot infections in advance of the line of general occurrence of the disease, to restrict its spread to this area The great chestnut forests of the state which, according to the state department of forestry, have a total valuation of approximately $50,000,000, are still essentially untouched by the disease, and the great object of the proposed legislation is to save these Experiments made by the national department of agriculture appear to have demonstrated practical methods of quarantine

against this disease, and Pennsylvania is the first state to undertake these methods on a large scale

THE Association of American Geographers will publish, beginning with this year, an annual volume to be known as the *Annals* of the Association This will be devoted to the most important scientific papers presented at the anual meeting The publication will be managed by a committee composed of Mr Alfred H Brooks, of the U S Geological Survey, Professor Henry C Cowles, University of Chicago, Professor Ralph S Tarr, Cornell University, and Professor Richard L Dodge, Teachers' College, Columbia University

THE *British Medical Journal* reports that the principal centers in India in which plague occurred during 1910, and the deaths consequent thereupon, were as follows Bombay Presidency, 36,831; Bengal, 30,546, United Provinces, 144,266, Punjab, 143,416, Central Provinces, 42,104, Rajputana, 37,657, Burma, 7,605 The following are the most recent general statistics October 22 to 31, 1910, 5,641; November, 26,189, December, 39,604 Total deaths, 71,434, making, with deaths, July to October 22, 20,828, total for half year, July to December, 92,262 During the first six months of 1910 the deaths numbered 360,632 Total deaths during 1910, 452,894 It would appear that the recrudescence of plague in 1911 has begun in a more virulent form than in 1910 In January, 1911, the deaths from plague in India numbered 75,468 This is a higher figure than in 1910, when in January the deaths amounted to 51,437

UNIVERSITY AND EDUCATIONAL NEWS

BY the will of Henry F Dimmock, of New York, Yale University will receive about $100,000 and under certain contingencies will receive twice this amount

IN addition to the regular course in general surveying, the School of Mines of the University of Arizona will start this year a summer school of mine surveying lasting through the month of June This course, which will cover the details of underground surveying, the construction of stope plans and other allied subjects, will be conducted by Mr Eugene R Rice, engineer of the Hite Gold Mines, city engineer of Wickenburgh, etc. The work will be done in one of the numerous mines near Prescott, Arizona

DR ARTHUR H WILDE, who has been connected with Northwestern University, Evanston, Ill, since 1892 and has been secretary of the university council since 1909, has accepted the presidency of the University of Arizona, at Tucson, and will take up his duties there on May 1

DEAN JULIET GREER, professor of domestic science and art of the Oregon Agricultural College, announces her resignation from the position which she has held for three years, the resignation to take effect the coming July

RICHARD SWANN LULL, B S, M S (Rutgers), Ph D (Columbia), assistant professor of vertebrate paleontology in Yale College and associate curator in the Peabody Museum, was made professor of vertebrate paleontology in Yale University at the corporation meeting of April 17. At the same meeting Dr George Grant MacCurdy was appointed assistant professor of archeology He is secretary of the American Anthropological Association and of Section H of the American Association for the Advancement of Science

NEW appointments and promotions at Stanford University for the academic year beginning August 1, 1911, are as follows

New Appointments

Noah F Drake, associate professor of economic geology Dr Drake is a graduate, A B, A M and Ph D, of Stanford University, professor of geology and mining in Imperial Pei Yang University, Tientsin, China, since 1898

Mr Henry V Poor, instructor in graphic art Mr Poor received his A B degree at Stanford, 1910, and is now studying abroad

Mr Jesse B Sears, instructor in education Mr Sears received the A B degree at Stanford, 1909, now instructor in the University of Wisconsin

Mr Harry J Sears, Stanford, A B, 1910, instructor in chemistry.

Miss Alice E Berger, Stanford, A B, 1908, acting instructor in chemistry

Promotions

Robert E Swain, to be professor of physiological chemistry

Lillien J Martin, to be professor of psychology

John O Snyder, to be associate professor of zoology

Percy E Davidson, to be associate professor of education

Rufus C Bentley, to be associate professor of education

LeRoy Abrams, to be associate professor of botany

Clara S Stoltenberg, to be associate professor of physiology

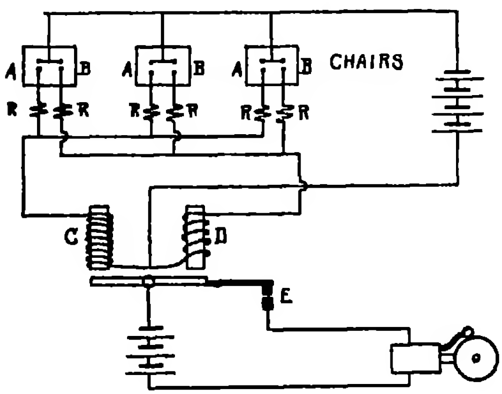
David M Folsom, to be associate professor of mining

Galen H Clevenger, to be associate professor of metallurgy

DISCUSSION AND CORRESPONDENCE

FACULTY BUSINESS ACCELERATOR

FOR the purpose of facilitating the despatch of business the following electrical device is suggested The method of operation will be evident from an inspection of the diagram of the electrical circuits All the chairs of the faculty room are fitted with electric circuits as indicated in the three chairs shown Each chair has two switches, those indicated by *B* are automatically closed when the chair is



occupied, those indicated by *A* are push-button switches concealed on the arm of the chair to be closed by hand *R, R, R,* etc, are suitable rheostats all of the same resistance It is evident that when any number of chairs are occupied the combined current through the switches *B* will excite the electromagnet *D* If the electromagnet *C* has twice as many turns of wire as *D* then, when a majority of those present at any meeting close the hand switches *A*, the magnet *C* will exert more pull upon the armature than *D*, thus causing the contact *E* to be closed and the bell to ring

The apparatus is not intended primarily as a means of taking formal votes but as an impersonal means of calling for the previous question In place of the bell it might be considered desirable to use an electric sign with the exhortation "*sit down*"

S

MUSEUM LABELING

ON the first two pages of the March issue of the *Museum News* of the Brooklyn Institute of Arts and Sciences are many ideas pleasing to those interested in museum labeling These stand out in contrast to some ideas with which museum men in this country, especially during the last decade, have been overwhelmed The art of label writing, as there stated, is truly a gift Many people fail to understand this and few realize that one must sometimes let an unsatisfactory label stand for a time, just as a minister sometimes preaches a poor sermon

The *Museum News* is almost an ideal example of what a museum newspaper should be It is dignified, conveys not only interesting but true information and also has a distinct tendency to cause the reader to wish to help not only the museums of Brooklyn, but the museums of the country

HARLAN I SMITH

WILKES'S ANTARCTIC DISCOVERIES

TO THE EDITOR OF SCIENCE The *Zeitschrift* of the Geographical Society of Berlin recently published a short notice[1] or review of my article "Why America should Reexplore Wilkes Land"[2] The reviewer finds fault with the article and attempts to straighten it out in the following words

[1] *Zeitschrift der Gesellschaft für Erdkunde zu Berlin*, 1910, No 7, p 469

[2] *Proceedings American Philosophical Society*, Vol XLVIII, 1909

Fur eine kraftige Wiederaufnahme antarktischer Forschung, und zwar in Wilkes Land durch Nord Amerika tritt Edwin Swift Balch mit Entscheidenheit vor Seine einschlägigen Darlegungen aber leiden durch die gänzlich ungerechtfertigte Annahme, dass die früheren Arbeiten der Nordamerikaner nicht nach Gebühr geschätzt, und in England ignoriert worden seien Das ist nicht geschehen Insbesondere hat die Fahrt von Wilkes an der Nordküste von Ost Antarktika immer volle Anerkennung gefunden, ist doch der Name Wilkes Land jenem Küstenstriche gegeben worden Aber Zweifel sind entstanden, da sich nicht alle Angaben von Wilkes als stichhaltig erwiesen haben Dies gilt insbesondere von den Angaben von Land auf einer Karte, welche Wilkes James Ross gegeben hat Bereits letzterer passierte am 6 Januar 1841 eine solche Stelle und fand hier tiefes Wasser, und seither hat Scott auf seiner Heimreise genau den Ort auf offener See passiert, wo Wilkes angibt, am 19 Januar 1840 3000' hohes Landgesehen zu haben Endlich hat E v Drygalski bekanntlich Termination Land nicht an der Stelle gefunden, wo es Wilkes es gesichtet haben will

In this short paragraph the reviewer makes five statements which call for an answer

1 and 2 The reviewer says it "has not happened" that the work of American explorers was ignored in England and also that Wilkes has had full recognition

In order to recognize the erroneous nature of these two statements it is only necessary to turn to many of the papers of Sir Clements R Markham, beginning with his article "Polar Regions"[3] and culminating in his article "The Antarctic Expeditions,"[4] in which he mentioned many of the more prominent Antarctic explorers, but ignored totally Wilkes's discovery of the mainland of East Antarctica and Palmer's discovery of the mainland of West Antarctica. Scott's various misstatements about Wilkes,[5] winding up in his silly assertion "thus once and for all we have definitely disposed of Wilkes Land," can also be cited as attempts at disparagement

Of course, some English writers are just and fair, and a shining example is Dr Hugh Robert Mill, who writes in accord with the evidence[6] and whose excellent work the reviewer might consult with profit

3 The reviewer repeats the old misstatement about Ross sailing over a part of Wilkes Land I supposed that I had killed that piece of fiction[7] and that Dr Mill had laid its ghost[8] This matter would take too much space for rediscussion here, and it seems sufficient to mention the fact that, as far as I am aware, my italicized statement "none of Wilkes's discoveries were disproved by Ross, for the simple reason that Ross never was within sighting distance of any part of Wilkes Land"[9] has never been challenged

4 The reviewer says that Scott passed "exactly the spot on open sea," where Wilkes states he saw land Now Scott makes no claim to sailing over any part of Wilkes Land On his return voyage, Scott sailed westward towards Cape Hudson, but when he got within about fifteen miles of where Wilkes had charted it—doubtless fifty miles too far north—Scott turned northward and sailed away A glance at Scott's chart[10] proves this absolutely and that Scott therefore did not disprove any of Wilkes's discoveries[11]

5 The reviewer says that Drygalski did not find Termination Land at the place where Wilkes said he had seen it. Now Wilkes, at the most westerly point of his memorable cruise along the northern coast of East Antarctica, saw appearances of land to the southwest and charted them as Termination Land. Then Drygalski on his cruise south discovered to the eastward a "high ice-covered land." And a comparison of the charts of the two explorers proves that Drygalski's "high

[3] "Encylopædia Britannica," ninth edition, American reprint, 1885

[4] *The Geographical Journal*, 1899, Vol XIV, pp 473–481

[5] "The Voyage of the Discovery," *passim.*

[6] "The Siege of the South Pole," 1905

[7] "Antarctica," 1902

[8] "The Siege of the South Pole," pp 246–247, 287

[9] "Antarctica," p 183

[10] "The Voyage of the *Discovery*"

[11] See "Wilkes Land," *The Bulletin of the American Geographical Society*, January, 1906

ice-covered land" must be the western edge of Termination Land

I explained this matter fully in an article "Termination Land"[12] That article was commented on in Germany at length by Dr Singer,[13] who concluded that there was no reason for leaving the name "Termination Land" off the charts, and who also published with his article an excellent map proving that Termination Land and Drygalski's high land are one It was also commented on by Dr H Wichmann[14] who stated likewise that there was no cause for taking the name Termination Land off the charts, and by Dr H Haack,[15] who wrote that Drygalski's assumption could not be kept upright That is to say, three leading German geographical authorities entirely agree with me as to Drygalski's high ice-covered land being Termination Land

EDWIN SWIFT BALCH

SCIENTIFIC BOOKS

Putnam Anniversary Volume Anthropological Essays presented to Frederic Ward Putnam in Honor of his Seventieth Birthday, April 16, 1909, by his Friends and Associates New York, G E Stechert & Co 1909

The pupils, colleagues and friends of Professor Frederic Ward Putnam have chosen the very happy and suitable method of celebrating his seventieth birthday by presenting him with a volume of original anthropological essays I had the pleasure of first meeting Professor Putnam at the Toronto meeting of the British Association in 1897 and was at once charmed by his personality Since then I have renewed my friendship with him on every possible occasion, and have been more and more impressed with his enthusiasm and knowledge I have seen the results of his labors in Cambridge, New York and Berkeley and have learned from his pupils how much they are indebted to him for their training, guidance and wise counsel But in addition to gratitude for these advantages they feel a personal affection for the man himself, which is shared also by his colleagues at home, in England and elsewhere It is as an honored and beloved master that his former pupils and friends offer this tribute

It is manifestly impossible to give an account of the twenty-five essays, but the following statement will give some idea of their scope A bibliography of over four hundred items indicates Professor Putnam's activity, but many of these are notes and annual reports It is interesting to find that Professor Putnam, like so many anthropologists, started his scientific life as a zoologist, for ten years he was curator of ornithology in the Essex Institute and later took charge of the Vertebrata Though most of his zoological papers deal with vertebrates, he also published a few papers on invertebrates In 1869 he published the first annual report of the Peabody Academy of Science, and his last purely zoological paper was published in 1879

By far the greater part of Professor Putnam's anthropological work was in the domain of archeology, so it is fitting that the first essay should be on "The Archeology of California," by an old pupil, A L Kroeber; thirty years previously Professor Putnam had written on the subject, and it is well known that the anthropological school of the University of California owes much to his wise direction This essay gives a bird's-eye-view of what has since been accomplished, and enables us to form some estimate of the civilization of the ancient inhabitants of California. Among the archeological papers is a beautifully illustrated memoir on "Ancient Zuñi Pottery," by J Walter Fewkes, which gives a needed synopsis of the old types of decorated vessels of the Zuñi, and the conclusion is drawn that the radical difference in the symbolism of prehistoric and modern Zuñi pottery confirms legendary evidence of the dual composition of the tribe. Charles C. Willoughby describes

[12] *The National Geographic Magazine*, Vol XV, May, 1904, p 221

[13] *Globus*, Vol 86, No 4, p 63

[14] *Petermann's Geographischen Mitteilungen*, 1904, Heft VII, p. 2

[15] *Geographischer Anzeiger*, 1904, IX, p 201.

in an illustrated article the "Pottery of the New England Indians", this falls into three groups, Archaic Algonquian, Later Algonquian and Iroquoian. "The Slip Mound," which is described by William C Mills, belonged to the highest culture of pre-Columbian man in Ohio, the builders of the mound had an intertribal trade, as evidenced by the copper from the Lake Superior region, the ocean shells and alligator teeth from the far south, and mica from North Carolina Mr Warren K Moorehead in his "Study of Primitive Culture in Ohio" establishes Professor Putnam's classification of the remains into the Fort Ancient and Hopewell cultures and adds an earlier one of the "Glacial Kames" The Hopewell culture, to which the Seip Mound belongs, migrated from the south, and the original contention of Professor Putnam that the southern people had short heads and the Fort Ancient people had long heads has been proved Marshall H Saville gives a beautifully illustrated paper on the cruciform structures of Mitla and its vicinity; the form of the cross was connected with the cult of Quetzalcoatl and is proof of the widespread range of the Nahuan pantheon, for we find his worship throughout the area of the Mayan culture, as well as in different parts of Mexico George B Gordon deals with the treatment of the macaw in Mayan art at Copan, and C W Mead with the fish in ancient Peruvian art Mrs Zelia Nuttall shows that the art of dyeing cloth by means of the *Purpura patula* has been continued in Mexico from pre-Columbian times to the present day, and points out that in the old and new world alike these are found in the same close association (1) the purple industry and skill in weaving, (2) the use of pearls and conch-shell trumpets; (3) the mining, working and trafficing in copper, silver and gold, (4) the tetrarchial form of government, (5) the conception of "four elements", (6) the cyclical form of calendar The tribal structure of the Omaha is lucidly described by Miss Alice C Fletcher, and in a well-illustrated memoir A M Tozzer describes several religious ceremonials of the Navaho, who borrowed, to be sure, but they were by no means simply borrowers they adapted and developed and, in many cases, especially in regard to the sand pictures, they did everything but actually invent the idea Papers on linguistics are given by F. Boas (Iroquois), Roland B Dixon (Wintun) and John R Swanton (Siouan) S A Barrett describes the elaborate numerical system of the Cayapa of Ecuador and Charles P. Bowditch discusses some dates and numbers of the Dresden Codex. It is characteristic of the trend of American anthropology that there is only one paper on physical anthropology, that of Aleš Hrdlička, on the stature of the Indians of the southwest and of northern Mexico There are a few papers which deal with non-American subjects, such as Charles Peabody's essay on certain quests and doles, which is a very interesting study on a neglected branch of European folk-lore, and F N Robinson's notes on the Irish practise of fasting as a means of distraint, it being regarded as a procedure which it was in some way dangerous to resist G L. Kittredge in a learned essay brings evidence of a tradition of very long standing which asserts that Hercules set up pillars at both ends of the world, that is at the eastern end as well as the western Professor Putnam, as some of his students have assured me, is a stimulating teacher, which, however, could be readily inferred from the mark his pupils have made in our science, and doubtless he has thoroughly appreciated the development of his ideas in very excellent scheme of instruction in primitive industries suitable for a normal college course by Harlan I Smith.

This brief notice of an important collection of essays may fittingly conclude with an endorsement of the final paragraph of the dedication of the volume to Professor Putnam by Professor Boas

May many years of health and strength be granted you to see the ripening of your plans and the achievements of your younger friends, whose progress has always been a chief pleasure to your life!

Alfred C. Haddon

Blue Hill Meteorological Observatory,
December 7, 1910

Municipal Chemistry A series of thirty lectures by experts on the applications of the principles of chemistry to the city, delivered at the College of the City of New York, 1910 Edited by CHARLES BASKERVILLE, Ph.D., F.C.S. New York, McGraw-Hill Book Company 1911 Pp 526 $5.00 net

The title of this book is sufficiently suggestive of its intended scope The lectures here brought together in printed form were given before the student body of the College of the City of New York in the spring of 1910 and were open to the public The interest they aroused was taken as sufficient to warrant the publication for a larger audience

Chemistry plays a very important and ever-widening part in the affairs of life, and especially of the life as it is lived in a great city Problems of food supply and preservation, of pure water and disposal of sewage, of garbage cremation and smoke prevention, and a dozen more which might be easily mentioned, call for the aid of the chemist in some direction It is proper to present to young people in college the conception of the chemist as a man who can do things which the city needs, and on a broad scale The chemical problems of the city are not merely those of routine analysis, although many analyses may be necessary in their solution

The men selected by Professor Baskerville to deliver the course of lectures are, for the greater part, well known authorities in their several specialties, and while some of the topics discussed bear but a remote relation to questions of municipal chemistry, in the narrower sense, it must be admitted that they are all of interest at the present time The editor contributes a good introductory lecture The papers by Professor Mason on the relations of drinking water to disease and on the purification of water, by Mr Flinn, of the New York Board of Water Supply, on the water problem in that city and the work in the Catskill Mountains, and by Professor Winslow on the disposal of sewage are perhaps the most interesting in the book The discussion of the city milk supply problem by Dr Darlington is also timely and quite worth reading

In addition to these topics there are lectures on food and drug adulteration, on illuminating gas, smoke prevention, ventilation, explosives, paints, corrosion of metals, cements, road building, textiles, parks and playgrounds It will be seen that a wide range of topics is covered, and in general in a way to interest young people The whole presentation is naturally elementary and not of a character to appeal to specialists In fact, the moderately informed man will recognize most of the discussions as old friends with which he is already familiar But the book is not intended for the well informed but for those who need and are seeking general practical information From this point of view it merits a cordial reception

J. H. LONG

SPECIAL ARTICLES

EXPERIENCES WITH THE GRADING SYSTEM OF THE UNIVERSITY OF MISSOURI[1]

WHY should there be uniformity of grading in an educational institution? somebody might ask If different grades were simply means of giving some students notoriety above others, the question would be immaterial, for a gentleman does not seek notoriety But the grade has in more than one sense a cash value, and if there is no uniformity of grading in an institution, this means directly that values are stolen from some and undeservedly presented to others

The result is that, among the members of the faculty as well as among the students, men look at each other with suspicion That this attitude is detrimental to the feeling of unity, to the development of a college spirit, is clear to even the most superficial observer. Whatever contributes to a greater uniformity of grading, contributes directly towards more peace, a better mutual understanding, a greater community of purpose among all the members of the institution

Whoever admits the fact just stated will find much encouragement in the present

[1] Read before Section L of the American Association for the Advancement of Science at the Minneapolis meeting

status of grading in the University of Missouri, compared with that of three years ago. At that time the university had the traditional marking system based on percentages of an ideal maximum accomplishment, called "100." There would be no objection to this system if all the grading in the institution were done by a single instructor. Experience teaches that different instructors even in the same subject have very different conceptions of what this ideal maximum accomplishment "100" really is.

Among teachers of different subjects this difference of conceiving the maximum accomplishment becomes enormous. There can be then no uniformity of grading, and all the evils resulting from this condition find an open door. Three years ago the diversity of grading had reached such a degree that the faculty took a radical step, abolished the antiquated system and introduced the grading by rank. This does not mean that the teacher is in any way interfered with if he uses, for his private purposes, the marking by percentages of his ideal maximum accomplishment. But the institution no longer accepts such percentages for its official records. Instead the institution requires each teacher to report for each student his estimated rank among a hundred students. This method is a little complex on account of the hundred different grades. To simplify it the grades are united into groups by division lines, which, however, are not at all drawn by each teacher according to his own opinion, but fixed by authority of the faculty of the university. The teacher now divides his list of a hundred students (whom, according to rank, he has graded himself, of course, since no one else can do this) into four groups of twenty-five students each, or, if the teacher prefers, an executive officer of the institution can divide them into these groups.

The students of the first group are marked E or S. Either of these "grades," therefore, does not stand for any degree of accomplishment as defined by anybody, but stands for the numbers from 1 to 25. The faculty has not yet drawn the division line between those of the twenty-five to be marked E and those to be marked S. But the actual practise of two sessions has been to mark the first four E and the following twenty-one S. The following two quarters of the list are marked M. This is prescribed by the rule of the faculty and leaves the teacher no choice. The last twenty-five are again divided into two groups called I and F.

The faculty has again left it, at present, to the discretion of the teacher to draw this division line. But actual practise has shown itself in favor of separating the last seven of these twenty-five as failures, and marking the eighteen students remaining above these seven as I.

Of course, a teacher does not, as a rule, have classes of just a hundred students. But he can distribute the five grades in the same way whatever the actual number of his students. Only in small classes there is this difficulty left that in any semester the membership may be unusually good or unusually bad. The teacher, therefore, is not expected at all to comply with the rule until, possibly after several semesters or even years, he has reported to the official recorder of grades several hundred grades. Then, sooner or later in the case of different individuals, the faculty calls him to account for what he has done. In Missouri the faculty has a special committee charged with this general supervision of the grading.

The system has now been in use for over two years. Considering all the grades reported during these four semesters and three summer sessions, we find that the highest four per cent. are excellent (E), the following twenty-one are superior (S), the following fifty-two are medium (M), the next sixteen are inferior (I) and the last seven have failed (F), not taking into account decimals. The only deviation from the rule, then, consists in this that two of the eighteen students of the I class have been marked one step too high, as M. Such an amount of regularity in general was perhaps to be expected. More interesting is the variation of marking found among the individual teachers.

In order to compare the individual teachers,

let us represent graphically the marking by them of those students who according to the rule ought to be marked M and who are just one half of the total number, having twenty-five per cent above them and twenty-five below. Each of the seventy-two rectangles of the diagram of Fig. 1 represents by its horizontal extent these students. If every teacher

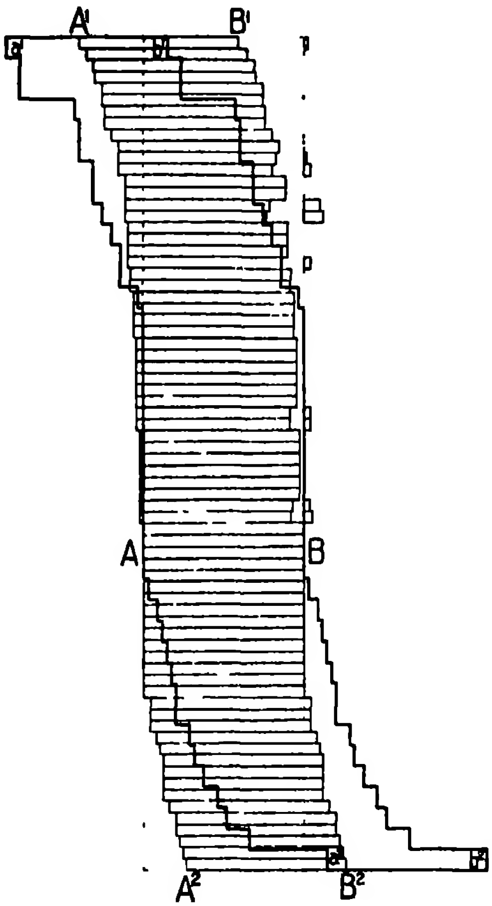


FIG. 1

had actually given all of these students the grade of M, these rectangles would lie exactly one over the other, forming the straight column indicated by the dotted lines. The greater the fraction of these M-students who have received from their teacher S instead of M, the more the particular rectangle reaches beyond the left border of the column. The most extreme case of this high grading is found above at A¹, B¹. Below where the rectangles reach beyond the right border of the column, we find those teachers represented who have given a fraction of their M-students the grade of I. The lack of uniformity may be measured by the ratio of the total area lying outside the column to that of the column itself. This ratio is about ten to a hundred, so that we may say that one tenth of the grades given are unjust in being either one grade too high or one grade too low.

The diagram which has just been explained represents the grading from the time of the introduction of the new system to the end of the first semester of the last session, that is, the grading of three semesters and two summer sessions. The last semester is not included because of a change made in the method of compiling the statistics. The diagram, further, represents only seventy-two teachers. Those who did not report, during the time mentioned, at least ninety grades, have been omitted. It would be unfair to include teachers who had so few students because in the case of these teachers the variations must be regarded as accidental. That the deviation from the standard amounts nevertheless to one tenth illustrates the great resistance with which the introduction of a new system of grading, the requirement of a new way of thinking, meets in a mind influenced by traditions of a different past. There seem to be still not a few teachers who report their E's, S's, etc., as if these grades represented well-defined or definable percentages of a maximum ideal accomplishment of "100" instead of rank. There seem to be others who only with difficulty get accustomed to the idea that we have now four passing grades, whereas formerly we had only three, and who on this account hesitate to assign the fourth grade, the I. However, that these deficiencies in the actual working of the system will speedily disappear seems to follow from the great progress already made, which becomes obvious when we compare the lack of uniformity under the present system of grading with that prevailing under the previous system.

In the same diagram the black lines represent in the same manner the grading by forty teachers of rather large numbers of B-students during five sessions of the university The former passing grades were A, B and C, and these were assigned, on the average, to 24 per cent, 35 per cent and 32 per cent of the students Since the B-group is the largest of these, it is best to use it for comparison with our present M-group The diagram shows what fractions of the B-students were given the grade of A (at the top) or a grade lower than B (at the bottom of the diagram) The scale of drawing, for comparison's sake, has been adjusted so that the central column of this case is identical with the central column for the M-students of the present system The diagram clearly shows that a large fraction of the B-students were formerly unjustly marked other than B, in figures, 24 per cent of them And worse than this, many students were graded two steps lower by one teacher than by another For example, take a student in the center of a file of B-students Under one teacher, at a[1], b[1], in the diagram, such a student standing just in the middle between a[1] and b[1] would invariably receive the grade of A Under another teacher, a student of the same rank of scholarship, standing in the middle between a[2] and b[2], could not entertain the slightest hope of getting a higher grade than C Moreover, the best of the B-students, at the point of a[2] in the diagram, would get no B under this teacher Such enormities of divergence have forever disappeared since the introduction of the new system Even the extreme cases of the M-students, A[1], B[1] and A[2], B[2], overlap to some extent The ratio expressing the lack of uniformity in grading was twenty-four to a hundred as short a time as two years ago It is now ten to a hundred I am confident that it will still further decrease in the near future The improvement already attained is really greater than it appears in the diagram, although it is there conspicuous enough The teachers who varied so enormously under the old system were all teachers of very large classes, so that there was no possible excuse for this variation I must point this out also for another reason Professor Dearborn, in discussing our former variations, thought that they were probably to be explained by the fact that teachers of small and advanced classes had been included in the statistics They were not

I am sure that any institution can in the same way make its grading more and more uniform, but only under the condition that the faculty does not expect mere legislation to accomplish the desired result Our experiences in Missouri prove conclusively that it is absolutely necessary for the faculty to have a special committee which collects each semester the cumulative results of the grading of each teacher and calls attention to those deviations from the rules which seem to be unwarranted We publish each semester among the teachers of the university a statistical table showing how each teacher has thus far graded his students I regard this publicity as essential to the success of our system Besides this, our committee collects data as to the relative standing of special classes of students, for example, athletes, fraternities, women, freshmen, etc

Although the method used by the individual teacher for ranking the members of his class is irrelevant to the system of grading under discussion, I wish to mention briefly the method used by myself because there is no end of complaint on the part of college teachers concerning the large amount of time which the teacher has to spend on examinations I use almost exclusively the conjectural or completion method which was introduced into psychological science by the late Professor Ebbinghaus for the measurement of general intelligence, but can be used with equal success for the measurement of the student's rank in a class The following is an example of an examination blank in which certain words have been omitted The student must fill in the blank spaces in such a manner that the whole becomes meaningful.

The fact of *simultaneous* color induction is well illustrated by the *Hering* window This consists of two narrow windows at some distance from

each other Any object then throws two shadows, one from each window The one shadow coming from the colorless window ought to be simply *dark*, but appears, if the other window contains, say, red glass, of a saturated *red* color because at this shaded spot no *white* light is mixed with the *red* light Everywhere else this mixed illumination takes place and makes the observer overlook the fact that the whole room with everything in it appears actually *reddish* The other shadow, coming from the red window, might be expected to appear simply *white*, since this shaded spot is illuminated only by *white* light As a matter of fact, it appears, by *induction*, *green* because the whole room excepting this spot stimulates on our retina the *red* process The area on the retina corresponding to this shaded spot is therefore the only one where the disturbed *equilibrium* of the components of the *red green* substance can be to some extent *restored* by spontaneous action of the sense organ (Words in italics are blanks)

The maximum number of points which any student could make in the quiz shown is fifteen In case the word inserted was not quite correct, but indicative of the right approach to the solution of the problem, one half point was given A class of twenty-six students made the number of points shown in the table below Students having the same number of points were given precedence according to the order in which they had been able to hand over their quizzes to the instructor Ranking these papers took about thirty minutes, and having completed the task the instructor felt sure that he had done no appreciable injustice to any of the students Ranking twenty-six different essays on the same subject, the Hering window, would have taken several hours, and the instructor would have finished his task with the unpleasant conviction that his ranking in many cases was arbitrary

	Points		Points		Points
1	15	10	12½	19	5½
2	15	11	12½	20	5½
3	14½	12	12	21	5½
4	14½	13	11½	22	5½
5	14	14	10	23	5
6	13½	15	9½	24	4½
7	13	16	7	25	4½
8	13	17	6	26	2½
9	12½	18	6		

I do not record the number of points made in any quiz by any student, but only his rank, placing those who "cut" at the bottom of the class I find that this is an excellent way of insuring class attendance At the end of the semester I sum up the rank numbers of each student and, by the smallness of the total, determine the rank for the whole semester By recording in each quiz, not the points made, but only the rank, we overcome the difficulties in grading caused by the fact that examinations are sometimes too easy, sometimes too hard In either case the best students come out on top, the poor students at the bottom, especially when we take into account, as mentioned above, the time within which each student completed his task

Let us take up another problem, which, it seems to me, is dependent on our system of grading, but which is by no means a part of this or any system of grading I believe that Professor Cattell was the first to point out the justice of giving more credit towards graduation to those students who ranked high in scholarship than to those who ranked low Now, the first and absolute condition of giving varying credit is a method of controlling the uniformity of grading in the institution Without this the injustice done by diversity of grading on the part of different instructors is only multiplied In the University of Missouri we credit an E with 30 per cent plus, an S with 15 per cent plus, an M with the normal credit, an I with 20 per cent minus and an F with nothing It must be understood that the choice of these quantities is for the most part experimental We are gathering data to put our credits on a more strictly scientific basis

I have heard of only one real argument questioning the justice of varying credit Some believe that by letting a student of excellent scholarship graduate after having taken a somewhat smaller variety of courses than the average student, we give the degree to one who does not have the breadth of training which a college graduate ought to

possess. I must say that, judging from my own experience with students, this argument is a fallacious one. I have never had an excellent student in psychology who did not have a good knowledge in languages, in history, in biology, etc. Indeed, I am inclined to assert that his knowledge of these other sciences, his comprehension of the relation existing between psychology and these other sciences, made him an excellent student in psychology. And this, I think, holds good also for other studies, more or less. I therefore believe in varying credit. We ought not to make conditions in college unnecessarily different from conditions in life. In life too our credits vary.

The amount of credit which we give for different scholarly accomplishments depends on our view as to what is the distribution of such accomplishments in a large number of students. The division lines which we draw between the different grades, as explained above, also depend on our assumption of a definite curve of distribution. I am inclined to think that, owing to the insufficient data which we possess at present, we have to base our conclusions on the normal curve. Three years ago I had the honor of speaking on this very question before this section of the American Association. I then criticized certain conclusions drawn by Professor Hall. Since my criticism has been slightly misunderstood, I wish to repeat what I wanted to point out. I did not want to belittle Professor Hall's work on the distribution of scholarly abilities. But I held, and still hold, that Professor Hall found his students distributed in accordance with the normal curve simply because he believed, while he was teaching and examining these students, that they ought to be distributed thus. I shall try to make this clearer.

Fig. 2 shows two entirely different curves of distribution. You may be surprised that these are the same students in the same subject. The only difference is that the broken lines represent the outcome of a very difficult examination, requiring a large amount of reasoning; the continuous lines represent the outcome of an examination of the kind most commonly given by instructors, which enables most of the students to respond to a majority of the points correctly, especially when there

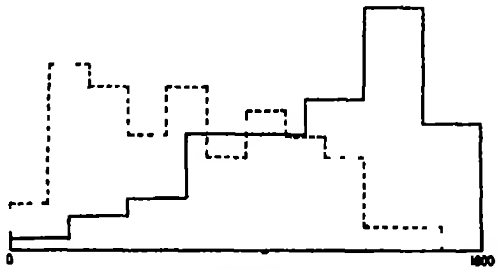


Fig. 2

is no time limit, or when the time of completing the task—of such enormous significance in life—is not taken into account at all. College teachers usually assert that the curve of distribution is not the normal curve, but a skewed curve like that of the continuous lines. They are usually ready to explain this by referring to the elimination of poor scholars in the high schools and lower schools. I have considerable doubts as to this elimination. Is the work done in a high school really so much like that done in college that there is a large previous elimination of poor college students? Our curves clearly show that the skewed distribution which an instructor finds is likely to be simply the result of the kind of examination which he gives. If he believes that the distribution ought to be like the curve of the continuous lines, he will give his examinations accordingly. If he believes otherwise, he will give his examinations otherwise.

I do not admit, then, that anybody has proved thus far that the distribution of scholarly accomplishments in college is like the normal curve or like a curve skewed either way. Under these circumstances, if for any purpose we have to assume, at least provisionally, a particular distribution, I see no other possibility than that of regarding scholarly accomplishments as based on biological properties and assuming the normal curve as the most probable one.

All this, however, does in no way interfere with our actual practise of grading Our division lines between the different grades may be drawn somewhat arbitrarily, the relative credit given for the different grades may be somewhat arbitrary, the injustice done the students under a system which enforces uniformity of grading is nevertheless small compared with the injustice when each instructor is left to grade according to his own fancy

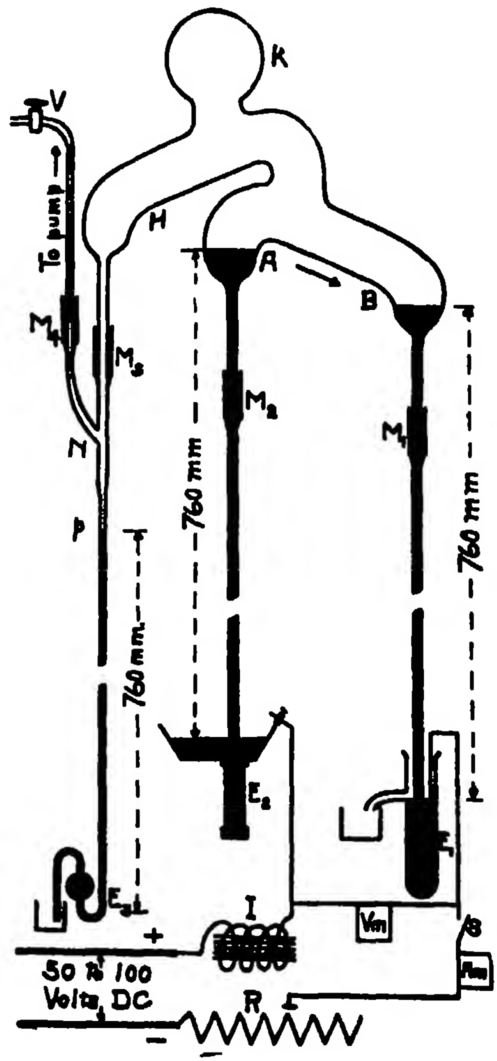
MAX MEYER
UNIVERSITY OF MISSOURI

AN EFFICIENT AND RAPID MERCURY STILL

IT is with some hesitancy that the writer attempts a description of so simple and commonplace an apparatus as a mercury still Nearly every laboratory has its own method of purifying mercury However, of the various "dry" methods that are usually employed two stand out prominently—Weinhold's method and Hulett's method[1] The principle of the first is to distil under reduced pressure or partial vacuum, while the second in addition to this makes use of a small jet of air bubbling up through the mass of mercury The jet of air plays the rôle of oxidizing the metallic impurities Both methods are good The purifying effect of air bubbling through mercury, even at room temperature, is now well recognized

In 1905 the writer described a new form of still,[2] in a brief paper read before the American Association for the Advancement of Science, at its New Orleans meeting, in which use was made of the mercury vapor lamp A description of the apparatus[3] as at present modified and perfected by several years' use in the laboratory is the object of this paper.

It is common observation that mercury condenses on the walls at the cooler parts of the lamp. Now by fusing to the mercury vapor lamp a properly shaped condensing chamber, mercury of a high degree of purity may be obtained. For the apparatus to be a practical working still the lamp must have additional modifications Fig 1 shows all of the essential parts The mercury arc is maintained between the electrodes A and B These electrodes are of mercury and are in communication, through the narrow barometric legs BE_1 and AE_2, with the vessels E_1 and E_2 containing the supply mercury These vessels are connected directly through an adjustable resistance and an inductance to some convenient source of direct current It is well to include



[1] Hulett, *Phys Rev*, Vol XXI, December, 1905
[2] SCIENCE, Vol XXIII, March 16, 1906
[3] Letters Patent, U S A, Nos. 891,264, 891,265; Germany, No 201,017

in the circuit an ammeter, a voltmeter and a switch as shown in the figure

The condensing chamber HK may have a variety of forms—the one sketched possibly serves the purpose best It will be noticed that the condensed mercury is, by the inclination of the tube H, diverted and leaves the still through a capillary delivery tube M_2E_2 bent into the form of an S at its lower end The action of the mercury dropping into this tube is that of a continuous mercury pump The nipple N for initially exhausting the system is fused, for convenience, to the upper end of this delivery tube M_1, M_2, M_3, M_4 are mercury seals

The operation of the still is very simple and when once under way needs but little attention Fill the vessels E_1 and E_2 with the mercury to be distilled and allow the mouth of the delivery tube to dip into a small beaker of clean mercury Now start the exhaust pump (an efficient mechanical pump will answer) and adjust the position of the vessels E_1 and E_2 until the electrodes A and B rise to the heights indicated in the figure The mercury in the delivery tube should now stand at some point p 5 or 6 cm below the nipple N To start the arc it is only necessary to lift the vessel E_1 slightly and allow a momentary stream of mercury to flow down the tube AB If the vacuum is right the arc should start instantly Adjust the current to the proper value After fifteen or twenty minutes the valve V may be closed, provided the various mercury seals do not leak The supply mercury is drawn mostly from the vessel E_2 and it therefore should be of large surface and rather shallow The vessel E_1 is provided with an overflow

The rate of distillation depends upon the size of the apparatus and the strength of current employed In the stills as first constructed the diameter of the tube AB was about 20 mm. This gave for a current of 4 amperes approximately one pound per hour. The corresponding fall of potential across the terminals was 21 volts Later the diameter of AB was increased to 40 mm and its length to 25 cm The size of the condensing chamber HK was proportionately larger This still gave for a current of 10 amperes approximately 2 pounds per hour. The potential difference across the terminals was 23 volts.

To test the purity of the distillate zinc amalgams were used The test for zinc was made by the electromotive-force method described by Hulett One millimeter deflection of the galvanometer corresponded to approximately 0005 volt The results are given in the following table

No	Zinc Amalgam	Distillate from Zinc Amalgam	Deflection of Galvanometer
2a	1 700,000	—	2 17 mm
100	1 370,000	—	4 00 "
a		1 1740	61 "
b		1 1740	19 "
c		1 1740	55 "

From numbers 2a and 100 we see that a deflection of 1 mm corresponded to the presence of zinc in the ratio of 1 1,500,000 Samples a, b, c were from an amalgam that was, comparatively speaking, very impure to zinc, yet the distillates condensed in three separate condensing chambers showed practically no trace of zinc The standard against which the above was balanced in the test cell was newly purchased commercial double distilled mercury and was in addition carefully and repeatedly purified by the "wet" method Numerous additional tests under various conditions have been made and all show that the still is capable of giving a distillate of the highest purity In fact, very pure mercury may be obtained by a single distillation even though the original is very impure As an example may be given a test in which the original mercury was excessively impure to zinc. After distilling off six or eight pounds the current was broken and the apparatus let stand over night. In the morning the anode was completely covered with a layer of zinc an eighth of an inch thick that had crystallized out on cooling The distillate showed scarcely a trace of zinc In this instance the arc was maintained by a small current density and consequently the average temperature[4] in the

[4] Knipp, *Phys Rev*, Vol XXXI, August, 1910

arc was very much below the melting point of zinc

The residue remains within the still This should be digested out from time to time, depending upon the condition of the impure mercury. Where one is dealing with comparatively pure mercury 50 to 75 pounds may be distilled off during a single run

CHAS T KNIPP

LABORATORY OF PHYSICS,
UNIVERSITY OF ILLINOIS,
January, 1911

THE ASSOCIATION OF AMERICAN GEOGRAPHERS

THE seventh annual meeting was held at Pittsburgh, December 29–31, 1910, under the presidency of Dr H C Cowles, of the University of Chicago His address was upon the subject, "The Causes of Vegetative Cycles" Public lectures were given by Professor Mark Jefferson on "Rocky Mountain Forms," and by Dr Cowles on the "Origin and Destiny of the Everglades" Professor Rollin D Salisbury conducted a round table conference on the "Purposes of Geographic Instruction, and the Phases of the Subject best adapted to these Purposes" About twenty five papers were read by the members

The following officers were elected *President* Professor Ralph S Tarr, Cornell University, *First Vice president,* Alfred H Brooks, U S Geological Survey, *Second Vice president,* Henry G Bryant, president of the Geographical Society of Philadelphia, *Secretary,* A P Brigham, Colgate University, *Treasurer,* Professor N M Fenneman, University of Cincinnati, *Councillor* (for three years), Professor Herbert E Gregory, Yale University

The following were appointed as delegates to the Geographical Congress to be held in Rome in October, 1911 Cyrus C Adams, A P Brigham, H C Cowles, W M Davis, H W Fairbanks and Ralph S Tarr

Members newly elected are Charles A Davis, U. S Bureau of Mines, F V Emerson, University of Missouri, Otto E Jennings, Carnegie Museum, Pittsburgh, Wolfgang L G Joerg, American Geographical Society, Alexander G Ruthven, University of Michigan, Victor E Shelford, University of Chicago, L H Wood, Western State Normal School, Michigan

The association has voted to establish a publication, and has appointed the following publication committee Richard E Dodge, chairman and editor, Alfred H Brooks, Henry C Cowles and Ralph S Tarr

Following the discussions of the round table conference, the association adopted the resolutions herewith appended

"The Association of American Geographers at its Pittsburgh meeting, December 29–31, discussed the present status of physical geography in secondary education and passed the following resolutions

"*Resolved,* that in the opinion of this association physical geography fully deserves to retain a place in the high school

"That the disappointment or dissatisfaction sometimes expressed regarding the results of teaching this subject is in large measure due to inefficient teaching

"That as a means of removing this dissatisfaction, superintendents and principals are urged to procure teachers of physical geography adequately prepared in their subject, and to entrust the subject only to such teachers

"That no teacher of physical geography should be appointed in any educational grade who has not made serious and special study of the subject in a higher educational grade"

A committee on state educational bulletins was appointed to report at the next meeting N M Fenneman, chairman, W M Davis and R H Whitbeck

The next meeting will be held in Washington in connection with the American Association for the Advancement of Science

ALBERT PERRY BRIGHAM,
Secretary

SOCIETIES AND ACADEMIES

THE FOURTH ANNUAL MEETING OF THE ILLINOIS STATE ACADEMY OF SCIENCE

THE fourth annual meeting of the Illinois State Academy of Science was held Friday and Saturday, February 17 and 18, at the University of Chicago

About two hundred persons attended the combined sessions of the two days, and the excellence of the papers and the general air of enthusiasm which prevailed was on a par, if not in excess, of previous meetings The total membership is now four hundred and eight, of this number, thirty-seven were elected at the Chicago meeting A study of the geographic distribution of the membership is significant, as the annexed table shows

Chicago	118
Urbana	114
Springfield	30
Evanston	12
Decatur	10
Scattered	122

The above condition is a very gratifying result of the four years of the academy's efforts, but it is fully realized that it falls far short of the ideal toward which the state academy is aiming There is no apparent reason why the Illinois State Academy of Science should not, in a few years, have an enrolment of a thousand members and wield an influence for good which will be felt not only by the educational institutions and the citizens of our great commonwealth, but also by our sister states whose state academies preceded ours by several decades

The following officers were elected for the ensuing year

President—W A Noyes, Illinois State University, Urbana, Ills

Vice president—J C Udden, Augustana College, Rock Island, Ills

Secretary—Frank C Baker, The Chicago Academy of Sciences, Chicago

Treasurer—J C Hessler, James Millikin University, Decatur, Ills

The following committees were appointed or continued

Membership Committee—H C Cowles, Chicago, Marion Weller, De Kalb, E N Transeau, Charleston, C C Adams, Urbana, J W Read, Jacksonville

Committee to Investigate the Status of High Schools as to Practical Science—Worrallo Whitney, Otis W Caldwell, J P Gilbert, J C Hessler, J T Johnson

Committee to Arrange for the Editorship and the Publication of a Series to be known as the State Academy Leaflets on High School Science—T J McCormack, William C Bagley, J G Coulter, R D Salisbury, H S Pepoon

Publication Committee—The president, the secretary and A R Crook

Committee on Ecological Survey—Stephen A Forbes, V E Shelford, Frank C Baker, Charles C Adams, H A Gleason

Committee to Influence Legislation to Restrict the Collection of Birds and Eggs to Institutions and Accredited Individuals—F C Baker, I E Hess and F L Charles

Committee to Cooperate with Existing Agencies for Advancement of Nature Study in Elementary Schools—F L Charles, Ira Meyers and Ruth Marshall

The program was as follows (the papers and addresses will be published in Volume IV of the *Transactions*)

FRIDAY, 10 00 A M—*Botany Building*

Address of Welcome, Dean R D Salisbury

"Charles R Barnes In Memoriam," John M Coulter

"Frank G Barnes In Memoriam," R O Graham

"J A West," S A Forbes

"J C Stine In Memoriam," Frank Smith

"The Postglacial Life of Wilmette Bay" (lantern), Frank C Baker

"Description of Mine Rescue Stations" (lantern), H H Stoek

FRIDAY, 2 00 P M—*Botany Building*

"Mollusca of Piatt, Vermilion and Champaign Counties" (lantern), James Zetek

"Oil Investigation in Illinois" (lantern), R S Blatchley

"Seasonal Succession in Old Forest Ponds" (lantern), W C Allee

"Demonstration of Movement of Water in Leaves" (lantern), A H Cole

"The Chinese Mantis in Southern Illinois," C A Hart

"Eastward Extension of Certain Shales as Shown by Deep Wells," J A Udden

"Present Status of Illinois State Museum," A R Crook

"Demonstration of the Use of Oxygen in Mine Rescue Work," J M Webb

"Metallic Colors in Birds and Insects" (lantern), A A Michelson

FRIDAY, 8 00 P M—*Mandel Hall*

Presidential address, "The Problems of Plant Breeding," John M Coulter

SATURDAY, 9 00 A M—*Mandel Hall*

Symposium on Radio Activity "Radio Activity and Geological Phenomena," T C Chamberlin, University of Chicago, "Some of the Physical Properties of Radium," Henry Crew, Northwestern University, "Radium in Relation to Celestial Bodies," E B Frost, Yerkes Observatory, "Radio Chemistry," W A Noyes, University of Illinois, "The Biological Effects of Radium," W A Pusey, University of Illinois

Address "The Relation of the Soil to Plants," H C Cowles

SATURDAY, 2 00 P M —*Botany Building*

"A Preliminary List of the Ants of Illinois," M C Tanquary

"The Channahon and Essex Limestone," T E Savage

"Occurrence of *Glaotanium* in Illinois," E N Transeau

"Ecological Studies of the Prairie and Forest of Illinois," C C Adams

"A Handbook for Students of Animal Ecology," C C Adams

"Reproduction by Layering in the Balsam Fir and other Conifers" (lantern), W S Cooper

"Evaporation and Plant Succession on the Sand Dunes of Lake Michigan" (lantern), George D Fuller

"Structure of Adult Cycad Stem" (lantern), C J Chamberlain

"An American Lepidostrobus" (lantern), John M Coulter and W J G Land

Following the presidential address, a social hour was enjoyed in Hutchinson Hall The social possibilities of the meetings were also taken advantage of during the noon day luncheons served in the men's commons

FRANK C BAKER,
Secretary

THE BIOLOGICAL SOCIETY OF WASHINGTON

THE 182d regular meeting of the society was held March 18, 1911, with President David White in the chair

Under the heading "Brief Notes," C D Marsh called attention to a recent paper on the "Geographic Distribution of Diatomes," by Tollinger, published in *Zoologische Jahrbucher*, Jena The paper is chiefly remarkable for its completeness A separate map of the distribution of each species is given

The following communications were presented

Raising Trailing Arbutus from the Seed FREDERICK V COVILLE

A brief account of scientific phases of the experiments, the results of which were outlined, appears elsewhere in SCIENCE The speaker exhibited a number of pots showing magnificent specimens produced from the seed and grown in the greenhouse

Notes on Java Natural History and Salt Makers of Tjihara, Java WILLIAM PALMER

This was a narrative of experiences and observations made during a somewhat lengthy collecting trip to Java in 1909 and 1910 It included observations on the physical features of the island, the vegetation, the inhabitants, their mode of life and industries, the birds, mammals and other animals The speaker closed with an account of his visit to the salt makers of Tjihara

D E LANTZ,
Recording Secretary

THE BOTANICAL SOCIETY OF WASHINGTON

THE 72d regular meeting was held at the Cosmos Club, Tuesday, April 4, 1911, at eight o'clock P M Both president and vice president being absent, Dr A Mann was chosen chairman *pro tem* Thirty members were in attendance

The following papers were read

The Study of Soil Organisms Dr N A COBB

Notes on some of the Edible Aroids R A YOUNG

The edible aroids are of great importance in the tropics, since they form a readily available source of starch food Practically all desirable varieties must be referred to the genera *Xanthosoma* and *Colocasia*, very few of those belonging to the genus *Alocasia* having any possible use Although the three genera can be distinguished with little difficulty the exact botanical nomenclature of the several varieties, especially those of the genera *Xanthosoma* and *Colocasia*, is in general uncertain

The acrid properties of the aroids, due to the presence of raphides composed of calcium oxalate in their tissues, are very pronounced However, the tubers of many forms are non acrid, and in *C gigantea* Hooker the entire plant is non acrid A peculiarity of the older leaves of this species is the development on the ventral surface of sharply defined, irregular, dark green discs on either side of the midrib

When the corms of the aroids are cooked a violet color develops, the source of which is at present unexplained

Inheritance of Aleurone Color in Corn Hybrids G N COLLINS

This paper reported the behavior of the aleurone color in a series of hybrids between diverse types of maize The aleurone color of corn, while of no practical importance, affords exceptional opportunities for studies of inheritance Being a part of the endosperm the characters of the aleurone cells are subject to xenia, that is, they develop from the union of the second nucleus of the pollen tube and the endosperm nucleus and may be looked upon as belonging to the same generation as the embryo Ordinarily in tracing the behavior of

characters it is necessary to grow hundreds of the hybrid plants or animals in order to secure reliable averages, while with xenia characters similar numbers can be secured by a single pollination and can be observed the same season that the cross is made.

Crosses between white varieties and those possessing a variety of aleurone colors has shown that the law of dominance holds with considerable regularity. Instances of partial dominance occur but are comparatively infrequent. One case was reported in which a blue aleurone color was definitely recessive to white. In the second or perjugate generation segregation, while comparatively definite, seems not to result in the usual ratios. Out of 200 different combinations only 16 approximated the usual ratios of a monohybrid. There was a great variety in the ratios obtained, the most frequent being one colored to two colorless, or 33⅓ per cent. This was approximated within twice the probable error in 22 instances out of 200. It was pointed out that this 1:2 ratio could not be explained by supposing that pure recessive or pure dominants were unable to develop. The regular arrangement of seeds on the ear would render omissions of this kind apparent.

Since the number of seeds on the individual ears was large enough to afford reliable averages, it was held that the differences found were significant, while any attempt to explain the unusual ratios by assuming different combinations of distinct factors for the same character would reduce the whole conception to an absurdity.

W. W. STOCKBERGER,
Corresponding Secretary

THE ANTHROPOLOGICAL SOCIETY OF WASHINGTON

THE 452d regular meeting of the society was held in the hall of the Public Library, February 21, 1911, 8 P.M., with Mr. George R. Stetson, vice president of the society, in the chair.

Dr. Daniel Folkmar presented a paper on "Some Questions Arising in the First Census of European Races in the United States." The speaker, who is chief of the section on the foreign born in the thirteenth census, and author of the "Dictionary of European and other Immigrant Races," dwelt at some length on the new feature introduced in the present census, namely, of classifying the foreign born by their mother tongue, in addition to that by country or political allegiance. The main part of the discourse was, however, occupied with a defense of the terminology, or nomenclature, adopted in the schedules of the census and in the dictionary, viz., "race" to designate the linguistic divisions of the immigrants, and "nationality" for the country of birth. The speaker admitted that in anthropology and biology the term race is applied to physical traits, but maintained that with the census it was not strictly a scientific question but a practical one, to designate and distinguish given groups of peoples who come to the shores of this country. "Race" seemed to him justified to designate linguistic groups, inasmuch as it points out something essential, which descends by heredity.

The paper as well as the dictionary, which the author laid before the society, were discussed at some length by Drs. Hrdlička, Michelson and Hough, and by Mr. Disserond.

I. M. CASANOWICZ,
Secretary

THE AMERICAN CHEMICAL SOCIETY
NEW YORK SECTION

THE seventh regular meeting of the session of 1910–11 was held at Rumford Hall in conjunction with the American Electrochemical Society, on April 7. Professor Chas. Baskerville presided.

The chairman announced that the section would be deprived of the pleasure of listening to Mrs. Ellen H. Richards at the May meeting by her death, which took place a short time ago, and called upon the secretary, one of her former students, to speak of her life and work. The chairman further announced the death of Mr. B. G. Amend, a former member of the section, and asked Dr. Chas. A. Doremus to say something in this connection. Following Dr. Doremus's remarks, the meeting rose in memory of the two deceased.

The chairman spoke of the work of the Municipal Explosives Commission and called upon Dr. C. F. McKenna to speak on "Suggestions as to Public Safety." The subject was further discussed by Dr. Wm. Jay Schieffelin and Mr. G. W. Thompson.

Professor Wm. H. Walker, president of the American Electrochemical Society, then made his presidential address entitled "Chemical Research and Industrial Progress."

At the conclusion of the address the chairman asked President Walker to preside. Dr. Walker took the chair and called upon Dr. H. E. Patten, of the Bureau of Soils, to present his paper on "The Relation of Surface Tension to Electrochemical Action."

C. M. JOYCE,
Secretary

SCIENCE

FRIDAY, MAY 5, 1911

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MSS intended for publication and books, etc., intended for review should be sent to the Editor of SCIENCE, Garrison-on-Hudson, N. Y.

RESEARCH AS A FINANCIAL ASSET[1]

IT is only in our century that there could be much significance to such a title as "Research as a Financial Asset" This is an industrial century, and, whether we are proud of it or not, we are an industrial people For some reasons it may be thought unfortunate that so large a proportion of man's energies should be devoted solely to the industries In some eras we find that there was a predominance of art over industry, in others literature was predominant, in still others war and conquest Once territorial discovery and acquisition predominated, and now, in our own times, the principles of community interest have so greatly developed that we are accustomed to seeing many people who, instead of directly producing their own necessities of life, are more generally producing some one little article which contributes in the lives of others This we recognize as a natural tendency to a higher efficiency Our intricate and delicately balanced system of work is becoming continually more complex, but is certainly still covered by the elemental laws of demand and of survival New discoveries in our day are largely mental, instead of geographical, and the old battles of conquest have become wars with ignorance They are struggles to overcome inefficiencies, attempts to broaden the common mental horizon, as our ancestors broadened their physical horizon Very few people realize the rapidity with which

[1] Presented before the Congress of Technology at the fiftieth anniversary of the granting of the charter of the Massachusetts Institute of Technology

technical advances are being made Few realize how the way of this advance has itself advanced I might make this more clear by an illustration

Consider for a moment the increasing uses of chemical elements and compounds New combinations in alloys, medicines, dyes, foods, etc, and new uses and new materials, are being produced daily For a more simple comparison, consider only the advances in our technical uses of the metallic chemical elements

Copper, iron and five other metals were known and used at the time of Christ In the first 1,800 or 1,900 years of our era, there were added to the list of metals in technical use (pure or alloyed) about eight more, or a rate below three a century There has been so much industrial advance made within the past twenty to thirty years that fourteen new metals have been brought into commercial use within this period This is almost as many in our quarter century as in the total preceding age of the world Of course this rate, as applied to metals, apparently can not continue, but there is no reason to question the possibility of the general advance it indicates For centuries a single metal was made to serve for all uses which that metal could fill Then two metals divided the field, each being used where it was preferred for any reason Alloys began to displace metals to a limited extent While the engineer still uses iron for his railroad, iron for his buildings and iron for his tools, these irons are different and have been specially developed for those uses The electrical engineer prefers copper for his conductor, certain irons for the frames of apparatus, other special irons and steels for the shafts, the magnetic fields, etc, and the specialization to best meet specific wants is still under way I suppose that this kind of complex development is largely responsible for research laboratories

A research laboratory is a place where men are especially occupied with new problems, presumably not too far in advance of technical application. By this group devoting its entire attention to the difficulties of realizing already well defined necessities, or of newly defining and realizing together, the efficiency of these processes is increased Men specially trained for this very purpose are employed and they are usually just as unfitted for successfully manufacturing as those who efficiently reproduce are of discovering or inventing It is merely an extension of the principle of the maximum efficiency A man with his entire attention devoted for months or years at a time to the difficulties of a single problem should be better able to reach a solution than the man who can devote only irregular intervals to it He should then also be the better prepared for a second problem

A research laboratory is also a place equipped with apparatus especially designed for experimental work In a busy manufacturing plant, if a foreman has an idea pointing towards an improvement of his product he frequently has great difficulty in finding the time, the necessary idle apparatus, the raw materials and the incentive to try it In the laboratory all of these are combined and there is added a system of cooperation, of permanently recording results and an atmosphere of research

The mathematics of cooperation of men and tools is interesting in this connection Separated men trying their individual experiments contribute in proportion to their numbers, and their work may be called mathematically additive The effect of a single piece of apparatus given to one man is also additive only, but when a group of men are cooperating, as distinct from

merely operating, their work rises with some higher power of the number than the first power. It approaches the square for two men and the cube for three. Two men coöperating with two different and special pieces of apparatus, say a special furnace and a pyrometer, or an hydraulic press and new chemical substances, are more powerful than their arithmetical sum. These facts doubtless assist as assets of a research laboratory.

When a central organization, such as a laboratory, has access to all parts of a large manufacturing plant and is forced sooner or later to come into contact with the various processes and problems, the various possibilities and appliances, it can hardly fail to apply, in some degree, the above law of powers.

As a possible means of illustrating the almost certain assistance which one part of a manufacturing plant may give another when they are connected by experimenting departments or research laboratories, and how one thread of work starts another, I will briefly review part of a single fairly connected line of work in our laboratory. In 1901 the meter department wanted electrically conducting rods of a million ohms resistance. These were to be one quarter inch diameter by one inch length. In connection with this work we had to become fairly familiar with published attempts at making any type of such high resistances. Some kind of porcelain body containing a very little conducting material seemed a fair starting formula after the resistance of almost all kinds of materials had been considered. Our own porcelain department was of a great help in showing us how to get a good start. We learned how and what to mix to get a fair porcelain, and we found that small quantities of carborundum or of graphite would give us the desired resistance about once in a hundred trials. The rods could be made, but the variation of their resistance when taken from the porcelain kiln and when they were made as nearly alike as we could make them, was often so many thousand fold that something now had to be done to make a practical success. A small electric furnace was then devised for baking the rods and this was so arranged that the rate of rise of temperature, the maximum temperature reached and the duration of heat at any temperature was under control and was also recorded. The desired result was obtained and this work was thus finished. It gave us a certain stock of knowledge and assurance.

At that time a very similar problem was bothering one of the engineering departments. Lightning arrester rods, part of the apparatus for protecting power lines from lightning, were needed. Their dimensions were $\frac{3}{4} \times 6$ inches and they needed to have a definite but, in this case, *low* resistance, and could apparently not be baked in a porcelain kiln. The necessary variations in such a kiln are so great that in practise many thousand rods were repeatedly fired and afterward tested to yield a few hundred of satisfactory product. All the cost of making an entire batch would have to be charged against the few units which might be found satisfactory, and in many cases there were none good in a thousand tested. It was evident that regulation and control of temperature was necessary. This was found to be impracticable in case any considerable number were to be fired at one time, as the heated mass was so great that the rods near the walls of the retort received a very different heat treatment from those near the middle and were consequently electrically different. This was still the case even when electrically heated muffles were used. This difficulty led to experiments along the

line of a heated pipe, through which the rods could be automatically passed. Some time was spent in trying to make a practical furnace out of a length of ordinary iron pipe, which was so arranged as to carry enough electric current to be heated to the proper baking temperature. Troubles here with oxidation of the iron finally led to substitution of carbon pipes. This resulted in a carbon tube furnace, which is merely a collection of six-foot carbon pipes, embedded in coke powder to prevent combustion, and held at the ends in water cooled copper clamps, which introduce the electric current. By control of this current the temperature could be kept constant at any point desired. When this was combined with a constant rate of mechanical feed of the air dried rods of porcelain mixture, a good product was obtained. For the past seven years this furnace has turned out all the arrester rods, the number produced the last year being over 100,000 units.

In this work we were also forced to get into close touch with the electroplating department. The rods had to be copper plated at the ends, to insure good electrical contact. The simple plating was not enough. This introduced other problems, which I will pass over, as I wish to follow the line of continuous experiment brought about, in part, at least, by a single investigation. The electric furnace consisting of the carbon tube packed in coke was a good tool for other work, and among other things we heated the carbon filaments for incandescent lamps in it. We were actuated by a theory that the high temperature thus obtainable would benefit the filament by removal of ash ingredients, which we knew the ordinary firing methods left there. While these were removed, the results did not prove the correctness of the theory, but rather the usefulness of trying experiments. It was found by experiment that the graphite coat on the ordinary lamp filament was so completely changed as to permit of a hundred per cent. increase in the lamp life or of a 20 per cent. increase in the efficiency of the lamp for the same life, so that for the past four or five years a large part of the carbon lamps made in this country have been of this improved type. This is the metallized, or Gem lamp. Naturally, this work started a great deal of other work along the lines of incandescent lamp improvement. At no time has such work been stopped, but in addition to it, the new lines of metallic filament lamps were taken up. In fact, during the past five or six years, a very large proportion of our entire work has been done along the line of metallic tungsten incandescent lamps. In this way we have been able to keep in the van of this line of manufacture. The carbon tube furnace has been elaborated for other purposes, so as to cover the action under high pressures and in vacuo. Particularly in the latter case a great deal of experimental work has been carried out, contributing to work such as that connected with rare metals. In such a furnace, materials which would react with gases have been studied to advantage. Our experience with the metallized graphite led to production of a special carbon for contact surfaces in railway signal devices, where ordinary carbon was inferior, and suggested the possibility of our contributing to improvements in carbon motor generator brushes. On the basis of our previous experience and by using the usual factory methods, we became acquainted with the difficulties in producing carbon and graphite motor brushes with the reliability and regularity demanded by the motor art. Furnace firing was a prime difficulty. Here again we resorted to special electrically heated muffles,

where the temperatures, even below redness, could be carefully controlled and automatically recorded. This care, aided by much experimentation along the line of composition, of proportionality between the several kinds of carbon in the brush, etc., put us into shape to make really superior brushes. The company has now been manufacturing these for a couple of years, with especial reference to particularly severe requirements, such as railway motors. In such cases the question of selling price is so secondary that we can and do charge liberally for delicacy and care of operation in the manufacture.

This carbon work naturally led to other applications of the identical processes or materials. Circuit breakers, for example, are now equipped with a specially hard carbon contact, made somewhat as motor brushes are made.

It is not my intention to connect all of the laboratory work to the thread which seemed to connect these particular pieces of work, but rather to show the possible effect in accumulating in a laboratory, experiences which should show on an inventory.

Among other considerations which appeal to me is one which may be worth pointing out. Probably almost every manufacturing plant develops among its workmen from time to time, men who are particularly endowed with aptitude for research in their line. They are usually the inventors of the company. They are often discovered in spite of opposition. They are always trying new things. They are almost of necessity somewhat inefficient in the routine production. In many plants they are merely endured, in a few they are encouraged. In my mind their proper utilization is a safe investment. A research laboratory assists in such a scheme. Sooner or later such a laboratory becomes acquainted with this type of men in a plant and helps them in the development of their ideas.

It is not a perfectly simple matter to measure the value of a research laboratory at any one time. In the minds of some, the proper estimate is based on the money already earned through its work, which otherwise would not have been earned by the company. This is a fair and conservative method which in our generation ought to be satisfactory when applied not too early to the laboratories. It does not take into account what we may call the good-will and inventory value, both of which should be more rapidly augmenting than any other part of a plant. The experience and knowledge accumulated in a general research laboratory is a positive quantity. In our own case we expended in the first year not far from \$10,000, and had little more than expectations to show for it. Our expenses rapidly rose and our tangible assets began to accrue. Perhaps I can point to no better criterion of the value of a research laboratory to our company than the fact that its force was rapidly increased by a company which can not be particularly interested in purely academic work. Our annual expenditures passed the \$100,000 mark several years ago. My own estimate of the value would probably be greater than that of others, for I am firmly convinced that proper scientific research is demanded by the existing conditions of our technical age.

Without going into exact values, which are always difficult to determine, consider for a moment the changes which incandescent lighting has witnessed in the past ten years. In this field our laboratory has been active, in contributing to both carbon and to metallic filaments. Moreover, all of the improvements in this field have been the product of research laboratories of trained

men In the case of our metallized carbon filament, which has now been in use several years, the efficiency of the light was increased by about twenty per cent Among the carbon lamps of last year these were sold to the extent of over a million dollars

A broader, but perhaps less accurate impression of changes recently produced, may be gained by considering the economy now possible on the basis of our present incandescent lamp purchases in this country and that which would have resulted if the lamps of only ten years ago were used in their stead On the assumption that the present rate of lamp consumption is equivalent to about eighty million 25 watt tungsten lamps per year, and on the basis of one and a quarter watts per candle power as against 3 1 of the earlier lamps and charging power at 10 cents per kilowatt hour, we get as a result a saving of $240,000,000 per year, or two thirds of a million per day Naturally, this is a saving which is to be distributed among producers, consumers and others, but illustrates very well the possibilities It is interesting to note that we are still very far removed from a perfect incandescent illuminant, when considered from the point of view of maximum theoretical light efficiency

I see from advertisements that 65,000 of the magnetite arc lamps, originally a product of the laboratory, are now in use These must have been sold for something near $2,000,000 The supplying of electrodes, which we make and which are consumed in these lamps, should amount to about $60,000 per year

Our study of the properties of the mercury arc produced our rectifier, which has been commercially developed within the past few years Of these, about 6,000 have been sold As they sell for not far from $200 per set, it is safe to say that this also represents a sale of over a million dollars The advantage of these outfits over other available apparatus must also be recognized as not far from $200 for each hour through which those already sold are all operating

In such a complex field as insulations and molded materials there have been many changes produced As far back as 1906 we were using annually, in a certain apparatus, 30,000 specially drilled and machined soapstone plates, which cost $1 10 each As the result of experiments on substitutes for such material, it was found that they could be molded by us in the proper shape, with holes in place and of a material giving increased toughness, at a greatly reduced cost As the result of this fact, the price of the purchased material was reduced to us from $1 10 to 60 cents which in itself would have paid for the work But further developments proved that the new molded material could be made for 30 cents, which the foreign material could not equal, so we have since produced it ourselves This caused a saving of approximately $24,000 annually for this one molded piece I have heard of other cases where prices to us have gone down, when we have obtained a little promise from our experimental researches

In considering the research laboratory as a financial asset there is another view which might not be visible at first sight It is the question of the difference between the value of the useful discovery when purchased from competitors in the business and when made by one's own company It is not usually pleasant to have to purchase inventions after their value is known, no matter from whom, but to have to pay a competitor for such a discovery is doubly irksome One is naturally unduly fearful of its value to the competitor, and he, in turn, is overestimating another's power to use it The purchaser's profit is

apparently limited to the differences between his efficiency of operating it and that of the original owner A business usually comprises processes of making and selling something at a profit, and study of the making of the most modern, most improved, most efficient, is about as essential as the study of the limits of safe business credits

I was recently informed by an officer of another large manufacturing company, where much chemical work is done and which established a research laboratory several years ago, that the most important values they got from their laboratory was the assurance that they were keeping ahead and are at least prepared for the new, if they can not always invent it themselves Incidentally, he said that from one part of their research work they had produced processes, etc, which had saved $800,000 a year They are at present spending in their several research departments a total of about $300,000 a year

We hear frequent reference to the German research laboratories and a brief discussion may be in place For the past fifty years that country has been advancing industrially beyond other countries Not by newly opened territories, new railroads, new farm lands, new water power cities, but by new technical discoveries In fact, this advance may be said to be largely traceable to their *apparent* over-production of research men by well fitted universities and technical schools Every year a few hundred new doctors of science and philosophy were thrown on the market Most of them had been well trained to think and to experiment, to work hard, and to expect little The chemical manufactories began to be filled with this product and it overflowed into every other calling in Germany These well educated young men became the docents, the assistants and the professors of all the schools of the country They worked for $300 to $500 per year They were satisfied so long as they could experiment and study the laws of nature, because of the interest in these laws instilled into them by splendid teachers This condition soon began to make itself manifest in the new-making of things--all sorts of chemical compounds, all kinds of physical and electrical devices I might say that pure organic chemistry at this time was academically most interesting Its laws were entrancing to the enthusiastic chemist and consequently very many more doctors were turned out who wrote organic theses than any other kind What more natural than that organic chemistry should have been the first to feel the stimulus? Hundreds, and even thousands of new commercial organic products are to be credited to these men and to that time All the modern dye stuffs are in this class Did Germany alone possess the raw material for this line? No! England and America had as much of that But Germany had the *prepared men* and made the start

It seems to me that America has made a start in preparing men for the research work of its industries For example, it is no longer necessary to go abroad to get the particular training in physical chemistry and electro-chemistry which a few years ago was considered desirable Advanced teaching of science is little, if any more advanced in Germany to-day than it is in this country In my opinion the quality of our research laboratories will improve as the supply of home trained men increases, and the laboratories of this kind will be increasingly valuable when analyzed as financial assets I am certain, too, that the industries will not be slow in recognizing the growing value of such assets They merely want to be shown

Probably in most industries there are

what I may call spots particularly vulnerable to research For example, the efficiency of steam boilers, based upon the heat energy of the coal used and the efficiency of the engine using the steam, are continually being raised We may expect, until the maximum calculable efficiency is reached, that this advance will continue The reason is not far to seek It is a vulnerable spot Improvement is possible A small increase in efficiency of a power plant is an ever-continuing profit Great numbers of steam power plants exist and so inventors are influenced by the fact that new improvements may result in enormous total economies Every rule of the game encourages them I can make this clearer by illustrations

Artificial light is still produced at frightfully poor efficiency Electric light from incandescent lamps has been greatly improved in this respect, but there is still room for greater economies It is still a vulnerable spot

In the case of iron used in transformers, we have another such vulnerable spot A transformer is practically a mass of sheet iron, wound about with copper wire The current must be carried around the iron a certain number of times and the copper is chosen because it does the work most economically No more suitable material than copper seems immediately probable, nor is there any very promising way of increasing its efficiency, but in the iron about which it is wound there is a vulnerable spot The size of the iron about which the copper is wound may possibly be still much further reducible by improvements in its quality In other words, we do not yet know what determines the magnetic permeability or the hysteresis of the iron, and yet we do know that it has been greatly improved in the past few years and that it can still be greatly improved

Let us make this vulnerable point a little clearer by considering the conditions here in Boston I assume there are approximately 50,000 kw of alternating current energy used here Nearly all of this is subject to the losses of transformers If the transformers used with this system were made more than ten years ago, they probably involve a total loss, due to eddy and hysteresis, of about $1,000 per day, at the ten-cent rate Transformers as they are made to-day, by using improved iron, are saving nearly half of this loss, but there still remains over $500 loss per day, to serve as a subject for interesting research work

It should also be noted that Boston uses only a very small fraction of the alternating current energy of this country

Consider for a moment two references to the sciences and industry in Germany and England Dr O N Witt, professor in the Berlin Royal Technical High School, reporting to the German government in 1903, says "What appears to me to be of far greater importance to the German chemical industry than its predominant appearance at the Columbian World's Fair, is the fact which finds expression in the German exhibits alone, that industry and science stand on the footing of mutual deepest appreciation, one ever influencing the other," etc As against this, Professor H E Armstrong, of entirely corresponding prominence and position in England, says of England "Our policy is the precise reverse of that followed in Germany Our manufacturers generally do not know what the word research means They place their business under the control of practical men , who, as a rule, actually resent the introduction into the work of the scientifically trained assistants " If the English nation is to do even its fair share of the work of the world in the future, its attitude

must be entirely changed It must realize that steam and electricity have brought about a complete revolution, that the application of scientific principles and methods is becoming so universal elsewhere that all here who wish to succeed must adopt them.

So long as motors burn out, so long as subways are tied up by defective apparatus, so long as electric motors run too hot, so long as street cars can catch fire from so-called explosions of the current, so long as the traffic of a whole city can be stopped by a defective insulation or a ten cent motor brush, there will probably be the equivalent of research laboratories somewhere connected with the electrical industries, where attempts will be continually made to improve

WILLIS R WHITNEY
GENERAL ELECTRIC COMPANY,
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RECLAMATION OF THE ARID WEST[1]

THE benefits derived by applying science to industry and the still greater benefits that may be expected when all great problems are attacked in the scientific spirit and on the scientific methods are to a certain extent exemplified by the opportunities afforded and results now accomplished in the conservation of the natural resources of the nation

The reclamation of the arid west is simply one of a number of items of national importance upon whose correct solution by true scientific methods rests largely, not merely the material prosperity of the nation, but, more than this, the perpetuation of free government, and of high standards of individual liberty

The stability of a republic or democracy, whichever we may term it, rests not upon its wealth, but upon the character of the individual citizen and voter. The greatest commonwealths are not necessarily those having the greatest natural resources, but rather those in which the human units are strong The strength of the unit, the family or the voter, is not derived from material wealth, but from ability to act and think independently and to exercise that intelligent self-interest which binds him to the great mass of his fellow men If, for example, he is working in a factory or on a railroad line, he is, of course, interested in keeping his job Beyond this, he has little concern with the condition of municipal, state or federal affairs These are entirely too remote to touch him, and if he lives in a tenement, he has no concern beyond paying his rent and getting the most he can for it

But take this man, indifferent to forms or details of government, and put him upon a 40-acre farm Assuming that he has reasonable industry and intelligence, his whole view-point of life changes He is transformed from being more or less of a nomad, shifting from flat to flat, or from town to town, and indifferent to the general welfare He now becomes a land-owning citizen and voter, interested in every public movement for better roads, better schools, better local government and everything which leads up to the stability of the institutions of the state as upon these rest the value and comfort of his home

This thought has been most pithily embodied in a statement attributed to Edward Everett Hale where he asks "Whoever heard of a man shouldering his musket to fight for his boarding house?"

The problem of the reclamation of the arid west is being attacked primarily for the purpose, not of making men rich, but

[1] Presented before the Congress of Technology at the fiftieth anniversary of the granting of the charter of the Massachusetts Institute of Technology

of strengthening the foundations of the state. It is an attempt being made by the federal government almost at the eleventh hour of its opportunities to utilize the waste resources still remaining at its command, and to employ these in such a way as to strengthen local communities and states, and to create in the more remote parts of the country many prosperous communities composed of independent, landowning citizens, each family being resident upon a farm sufficient for its support, and cultivating the soil intensively, under favorable conditions of sunlight and of water supply, such as to produce the largest crop yield per acre, and to bring about the largest individual success.

The people thus placed upon the farms are not merely producers. They not only raise enough to support themselves, and to sell to their neighbors, but indirectly they stimulate all industries. They are large consumers, as well as producers, and it may be said that for every family placed upon an irrigated farm on the desert, there arises the possibility of another family engaged in transportation or in manufacturing in the east or middle west. All parts of the country are thus linked together. The success of the irrigator in the west means larger cotton production in the south, more boots made in Massachusetts, more freight and passenger cars hauled across the continent.

The success already attained in applying scientific methods to this great problem of conservation of the waste resources of the country may be attributable in part at least to the Institute of Technology, and to the instruction there given. The Reclamation Service, organized under the act of June 17, 1902, includes among its principal men and guiding hands many graduates or students of the Institute of Technology.

The training at the institute has been peculiarly effective in building up in the minds of its students a grasp of the larger conditions, and a proper confidence in ability to handle these. The first thing in any undertaking, such as that of studying the resources of a nation, is to gain a comprehensive view of these and to set on foot investigations and measurements in detail such that the conclusions will have direct value and application to the larger problems involved.

With a comprehensive and reasonably accurate review of the conditions to be met, it is then possible to bring to the solution of the problem the principles and methods of engineering and to put into play the constructive ideas which are inseparable from a technologic education.

The great difference between the methods pursued at the institute and those at many of the older institutions appears to lie in this constructive idea in the inculcation of the conception that the great work of life is to initiate and to build on correct lines rather than to simply know what others have done, and to imitate those.

The constructive faculty, the ability to imagine or to picture desirable results, and to turn these into accomplishment by scientific methods is the foundation for success in these larger lines of work.

In the matter under consideration congress in 1888 authorized an investigation of the extent to which the arid lands might be reclaimed. This problem is enormous and its correct solution is fundamental to the future growth and development of the nation, because of the fact that one third of its area is arid. In that third are potentially some of the most valuable lands in the world.

The problem is to obtain water for these lands. This in turn rests upon questions of economics and engineering, in storage

of flood or other waste waters, and in the adjustment of a form of agriculture suited to these conditions The results already attained show that the lands are not only capable of supporting a large population, but under government auspices many thousands of families have been settled in prosperous homes and a highly desirable class of citizenship has been created in a most sparsely populated part of the country

As a natural outgrowth of the investigation begun in 1888, the so-called Reclamation Act of June 17, 1902, was passed, setting aside the proceeds from the disposal of public lands for the construction of works for the reclamation by irrigation of the arid and semi-arid lands It has been held that congress has absolute control over the public lands and of the funds arising from their disposal, and while it might be questionable as to whether the United States could levy taxes, and thus raise money for reclamation, it has been considered that congress could properly create a trust fund derived from the source named This fund has amounted to over $60,000,000, and is being added to at the rate of six or seven millions a year It has been invested in the construction of reservoirs, canals and distributing systems, and already twenty-seven projects have been initiated or completed, works having been undertaken in each of the western states and territories

Over a million acres have been reclaimed, and 14,000 families are receiving water from works built or controlled by the government, under the terms of this act Reservoirs have been built having a capacity of nearly 5,000,000 acre-feet, that is to say, the water would cover 5,000,000 acres to a depth of one foot Canals of large size, carrying over 800 cubic feet per second, have been built for a total length of 300 miles, and somewhat smaller canals constructed with a length of a thousand miles including the ditches There are over 5,000 miles of water courses, also nearly 70 tunnels with a total length of about 20 miles The smaller structures number over 20,000 including bridges, culverts, headgates, siphons, etc Nearly 60,000,000 cubic yards of earth have been excavated and 10,000,000 of loose and solid rock

The principal results, however, are shown in the crop production and although the works are hardly built to a point further than to try out productions it appears that the value of the crops raised in 1910 was nearly $20,000,000 Land values have advanced from practically nothing to one hundred million dollars These values will continue to increase as the works near completion

The object, however, as before stated, is not to make men rich, but to make homes for citizens who will preserve the institutions of the country, and to do this without imposing a burden upon the taxpayers It has been shown how this is being accomplished by the use of the reclamation fund, which is revolving and growing larger and larger, that is to say, as the money comes back from the works completed, it is used over again and is being increased by additions from the disposal of other public lands Under wise administration the funds should increase and produce larger and larger results in the conservation of the waste waters and the utilization of these in those parts of the United States where rain is infrequent and where the brilliant sunshine can be depended upon nearly every day in the year It is really the sunlight which is capitalized and made valuable

The question is frequently asked, why should not the government reclaim the

worthless lands in the east? The answer lies largely in the fact that no other part of the country than the arid west has such wonderful opportunities for crop production, as it does not have the continuous daily sunshine upon which plant life depends The advantages of the development in the arid region also are greater from the political standpoint, as population is better distributed and is brought nearer to important sources of mineral wealth, enabling development of industries in otherwise remote and inaccessible localities

All of these results are successful in proportion as they have been brought about by scientific methods, and by following the principles inculcated at the schools of which the Institute of Technology is chief

F H NEWELL

U S RECLAMATION SERVICE,
WASHINGTON, D C

THE ST LOUIS UNIVERSITY EXPEDITION TO COLORADO

IN a recent number of the *Fleur-de Lis*, one of the publications of the St Louis University, there appears an article on a geological expedition to Colorado, organized last summer by that university Its purpose was to afford an opportunity of geologic field-work to those teachers who were called upon to teach geology as an accessory subject, in addition to other regular work Accordingly, those who availed themselves of the opportunity were chiefly professors of physics and chemistry They were Professor John P. Coony, head of the department of chemistry, St Louis University Medical School, James I Shannon and Charles Cloud, professor and associate professor, respectively, of physics, and Theodore Schulte, professor of chemistry, St Louis University, Joseph Wilczewski and William Agnew, of the department of physics, St. Ignatius College, Chicago, A M Schwitalla, professor of chemistry, St Xavier College, Cincinnati, Vincent Jenneman, professor of physics, Sacred Heart College, Prairie du Chien, Wis ; Hugo Sloctemeyer, curator of the Mineralogical Museum, St John's University, Toledo, O

Colorado, and especially the foot-hill region, was chosen for its variety of geological formations within a comparatively small area Ten days were spent near Cañon City chiefly to study the occurrence and formation of igneous and metamorphic rock in the Royal Gorge of the Arkansas River Camp was then moved to Garden Park, ten miles north, where during four days attention was principally directed to the foot-hill topography and the strata profiles in Oil Creek Cañon The famous dinosaur beds of the region were also examined as carefully as was possible under the circumstances Finally, more than two weeks were spent in the Ute Pass near Manitou, where, besides special problems investigated by the individual members of the party, some coordinated work was done on the formations of the Manitou embayment, and the Archæan-Cambrian contact in this region The pedagogical character of the work was continually kept in mind, and the results were such as to warrant a repetition of the experiment

A M SCHWITALLA

RESOLUTIONS ON THE DEATH OF PROFESSOR CHARLES OTIS WHITMAN

AT the Ithaca meeting of the Eastern Branch of the American Society of Zoologists in December, 1910, it was voted that "the president appoint a committee to prepare a resolution on the death of Professor Whitman, the resolution to be published in the minutes of the society, and transmitted to the family of Professor Whitman" In accordance with this vote Professor S F Clarke and Professor F R Lillie were appointed on this committee They have prepared the following resolutions which have been incorporated in the permanent records of the society

The Eastern Branch of the American Society of Zoologists records with profound regret the death of Professor Charles Otis Whitman on December 6, 1910 Professor Whitman was one of the founders of this society, he was chairman

of the committee that issued the first call for organization of the American Morphological Society, the forerunner of the American Society of Zoologists, and he was president of the society for the first four years, 1891-94. He was organizer of the *Journal of Morphology* and its editor for many years, and in this capacity also exerted a strong influence on the development of zoological research in America. As director of the Marine Biological Laboratory for twenty-one years, he exerted an even more powerful and entirely unique influence in the development of biological science. As an investigator he was painstaking, enthusiastic and thorough, as a thinker on biological problems profound and far sighted. Devoted to principle, his uncompromising personality sometimes made enemies, but the charm of his character made him devoted friends. His influence will long remain as one of the most important forces in the history of zoology in America.

SCIENTIFIC NOTES AND NEWS

JOHN WILLIAM DRAPER, eminent for his contributions to physics, chemistry and physiology, was born on May 5, 1811, and the centenary of his birth is being celebrated by New York University, where he was professor from 1839 until 1873.

THE Paris Academy of Sciences has elected as corresponding members Professor Svante Arrhenius, of Stockholm, in the section for physics, and Professor I. P. Pawlow, of St. Petersburg, in the section of medicine.

AS already announced, the British Association will meet at Portsmouth on August 30. On the evening of that day, Sir William Ramsay will give the presidential address. Public lectures will be given by Mr. Leonard Hill on the "Physiology of Submarine Work," and by Professor A. C. Seward on "Links with the Past in the Plant World."

THE Association of German Men of Science and Physicians will hold its eighty-third meeting at Karlsruhe from September 24 to 30.

MR. J. H. GRISDALE has been appointed director of the experimental farm system of Canada, to succeed Dr. William Saunders.

PROFESSOR LOUIS DOREMUS HUNTOON, M.E., of the department of mining and metallurgy, Sheffield Scientific School, Yale University, has resigned his position to engage in work in the Canadian gold fields.

DR. F. W. WOLL, professor of agricultural chemistry in the University of Wisconsin, has been designated as the delegate of the university at the celebration of the centennial of the University of Christiania, Norway, September 2 to 6, 1911. Dr. Woll is a graduate of the University of Christiania.

PRESIDENT TAFT has appointed the following as the official representatives of the respective bureaus of the federal government on the organizing committee of the International Congress of Applied Chemistry: *Department of the Treasury*—Dr. Reid Hunt, Hygienic Laboratory, Marine Hospital Service; Dr. A. B. Adams, Internal Revenue Service. *Department of the Interior*—Mr. George Seiger, Geological Survey; Dr. George S. Ely, Patent Office; Professor Nathaniel W. Lord, Ohio State University, Columbus, O., to represent Bureau of Mines. *Department of Agriculture*—Dr. H. W. Wiley, Chief, Bureau of Chemistry; Dr. C. F. Langworthy, Office of Experiment Stations; Professor W. W. Cooke, Biological Survey; Mr. William L. Hall, Forest Service; Dr. Frank E. Cameron, Bureau of Soils; Professor W. J. Humphreys, Weather Bureau; Dr. R. H. True, Bureau of Plant Industry; Dr. Marion Dorset, Bureau of Animal Industry; Dr. W. F. Hillebrand, Chief Chemist, Bureau of Standards.

PROFESSOR K. L. HATCH, of the University of Wisconsin, has been elected president of the newly founded American Association for the Advancement of Agricultural Teaching in Secondary Schools, which was launched in Chicago at a meeting of all the heads of departments of agricultural education in the universities and colleges in the north central states. Representatives from the United States Department of Agriculture were also present. The purpose of the new society is to organize and systematize agricultural material so that it can be used with greater efficiency in propagating agricultural education through the medium of the high schools of the nation.

MR K F KELLERMAN, physiologist in the Bureau of Plant Industry, Washington, sailed for Europe on April 25 and will spend three months in a study of the progress being made in the investigation of soil bacteriology in Germany, Russia, France and England

DR CHARLES B ROBINSON expects to return to this country about the end of July Dr Robinson has been in the service of the Philippine Bureau of Science for over three years and it is understood has been collecting this spring along the Indo-China coast, a region very little known botanically

ON April 27 Professor R W Wood, of the Johns Hopkins University, began a course of three lectures at the Royal Institution on "The Optical Properties of Metallic Vapors," these being the Tyndall lectures

SIR JOHN MURRAY lectured before the New York Academy of Sciences on April 24, his subject being "The Depths of the Sea" On April 27 he lectured before the Geographical Society of Chicago on "The Ocean" After the lecture the Helen Culver gold medal of the society was conferred upon him

DR JACQUES LOEB, of the Rockefeller Institute for Medical Research, delivered the address at the annual conversational meeting of the Philadelphia Pathological Society, on April 27 His subject was "Fertilizing Effects of the Extracts of Tissues, Blood and Sperm" After the address a reception was given to Dr Loeb at the University Club

PROFESSOR LAFAYETTE B MENDEL, of the Sheffield Scientific School, Yale University, gave two lectures on "Nutrition" at Goucher College, Baltimore, on April 27 and 28

PROFESSOR E L MARK, director of the zoological laboratories of Harvard University, gave an illustrated lecture before the departments of geology and biology of Colgate University on the evening of April 21 His subject was "Some Vestigial Organs in Man"

DR MAXIMILIAN TOCH, head of the firm of Toch Brothers, manufacturers of paints, will give three lectures before the students of the Engineering School of Columbia University, on "Paints, Pigments and Drying Oils" Dr Toch was at one time assistant professor in Columbia

PROFESSOR G W RITCHEY, of the Mount Wilson Solar Observatory, at Pasadena, Cal, gave a public lecture under the auspices of the University of Minnesota Chapter of the Sigma Xi on April 21 on the subject "The Largest Telescope in the World and its use in Photographing the Heavens"

PROFESSOR SVANTE ARRHENIUS, Stockholm, Sweden, will deliver the third Weir Mitchell lecture of the Philadelphia College of Physicians on May 16 The subject will be "The Passage of Microorganisms through Interstellar Space a Theory bearing on the Origin of Life on a Planet"

A LIFE of Mrs Ellen H Richards is to be written with the approval of Professor Richards It is hoped that the story of her life may be of such a character that it will not only interest those who have known Mrs Richards either personally or through her work, but will also serve to extend her influence and to inspire future workers Any material, such as letters, photographs, characteristic sayings and incidents, which will help to show her personality and her interests and activities will be valuable to the editor, Miss Caroline L Hunt, and should be sent to her at 32 Eliot Street, Jamaica Plain, Mass

DR CHARLES STEDMAN BULL, professor of ophthalmology in the medical department of Cornell University, died on April 17, aged sixty-six years

MR T. RUPERT JONES, FRS, formerly professor of geology at Sandhurst, has died at the age of ninety-one years

MAJOR GEORGE LAMB, director of the Pasteur Institute of India and known for his important work on snake venoms, the plague and hydrophobia, died at Edinburgh on April 11, in his forty-second year

PROFESSOR EDUARD ZACHARIAS, director of the Botanical Institute of Hamburg, has died at the age of fifty-nine years

PROFESSOR A HOUZEAU, professor of chemistry in the Rouen Scientific School, has died at the age of eighty-two years

THE eighth annual meeting of the American Society of Tropical Medicine will be held in Tulane University, New Orleans, on May 18 and 19, under the presidency of Dr William S Thayer, of the Johns Hopkins University

WORD has been received from Professor Arthur H Quinn, secretary of the Association of Colleges and Preparatory Schools of the Middle States and Maryland, that the association accepts the invitation of Columbia University to hold the next meeting there The meeting will take place on December 1 and 2, 1911

ON the invitation of the departments of science of Princeton University, the teachers of science in New Jersey schools will hold their annual meeting in Princeton on May 27

IN a letter to Secretary Walcott, of the Smithsonian Institution, dated Bahia Blanca, Argentina, March 17, 1911, Mr Bailey Willis gives the following account of the initiation of the work which he is conducting for the Argentine government

You may care to know what progress we are making in the forty first parallel survey, south latitude We landed in Buenos Aires twenty days ago The topographers have now been at work a week on base line and station signals in northern Patagonia Washburne and Jones, geologists, went out to initiate themselves in the geology of a section that has been studied along the railroad that runs west from this city half way to the Andes Pemberton and I remained in Buenos Aires till yesterday, when we got our outfit aboard the steamer that takes it to Puerto San Antonio in northern Patagonia Now we are off with 120 mules and horses on a 200 mile ride across Pampa and plateau to San Antonio The region is almost waterless south of the Rio Negro We find that there is a basement of gneiss and granite, which comes to the surface here and there There are porous continental sandstones of Tertiary and Cretaceous ages, and also large areas of basalt Their distribution is unknown, but in the course of four or five months we shall know it, and the answer to the water problem will be worked out

IN his recent address at Madison, ex-President Theodore Roosevelt spoke as follows in regard to the University of Wisconsin: "It is not too much to say that the University of Wisconsin occupies a position entirely unique not merely in this country but in the world, as an institution which beyond all others has come the nearest to recognizing the ideals of using the instrumentalities of higher education for rendering the greatest possible service to the country The nation, as a whole, points to this state as the state in which the leading public men are not backed by the ordinary corporations that too many of our public men have been backed by in the past, but by the greatest educational institution in the state, and I have found everywhere on the Pacific slope and in the Rocky Mountains that the ambition of every state was to follow Wisconsin as the wisest and most far seeing progressive state, and to secure the same co-operation in their state between their government and their university in rendering service to the state, which obtains to-day in Wisconsin"

AT a meeting of executive officers of boards of health of New Jersey, held at Newark, N J, on April 17, 1911, a permanent organization to be known as "The Health Officers' Association of New Jersey" was formed A number of the more prominent health officers of the state were present The objects of the organization are, the advancement of knowledge relating to public health and sanitation and the encouragement of social intercourse among health officials The following officers were elected

President—C H Wells, Health Officer, Montclair

Vice president—John O'Brien, Jr, Health Officer, Plainfield

Secretary and Treasurer—J Scott MacNutt, Health Officer, Orange

An executive committee of seven was elected, and the officers, with the advice of this committee, were instructed to draw up a constitution and by-laws for presentation at the next meeting to be held May 17 The membership at present includes as eligible all health officials holding state board of health licenses, and doubtless will be extended to other health

board officials and employees and members of local boards of health Five or six meetings a year will be held for the presentation and discussion of papers Most of the prominent health board officials of the state have expressed themselves as strongly in favor of the association, which promises to grow rapidly in membership and influence

UNIVERSITY AND EDUCATIONAL NEWS

By the will of Ernest V Cowell, the University of California receives a bequest of $750,000 It is for a hospital, a gymnasium and an athletic stadium, each to cost $250,000

The Nebraska legislature has passed a bill, which the governor has signed, appropriating $100 000 with which to begin the development of the campus of the College of Medicine of the university, in Omaha The issue presented in the legislature was whether or not the state was ready to begin the development of a complete medical college plant, and the decision was affirmative, by a narrow margin in the house and by a wide margin in the senate

Dr Elmer Ellsworth Brown, U S Commissioner of Education, has been elected chancellor of New York University

Bruce Payne, Ph D (Columbia, 1905), professor of educational psychology in the University of Virginia, has been appointed president of the George Peabody College for Teachers at Nashville The old Peabody College has been disbanded and President Payne will have a free field in constructing the new one, which is to have new grounds, buildings and faculty, and one million and a half additional endowment

Professor H H Newman, chairman of the school of zoology, University of Texas, has resigned to accept an associate professorship of zoology at the University of Chicago All appointments in zoology at Texas have been made and the details will be made public in a subsequent number of this Journal

Dr Clinton R Stauffer, assistant professor of geology at the School of Mining, Kingston, Canada, has been appointed associate professor of geology in Western Reserve University.

Dr J J Laub, of Heidelberg has been appointed professor of theoretical physics and geophysics in the University of La Plata

DISCUSSION AND CORRESPONDENCE

THE REFORM OF THE CALENDAR

To the Editor of Science A recent letter by Professor Chamberlin in your journal entitled "Reform of the Calendar" has reinterested me in the subject and suggested the publication of another, and, it is hoped, more correct view of the subject A perusal of the article "Calendar" in Encyclopædia Britannica will suggest arguments in its favor, as to recent articles on the subject, time and inclination are lacking for their reading and the risk is run of anticipation on conflict

As the greater part of the eighteen folio pages in the Encyclopædia is under the head "Reformation of the Calendar" or treats of intricate peculiarities calling for reform, the legitimate effect of the article is the conclusion that what is needed and possible is not a reformation, but a

Simplification of the Calendar

Let us then state this as a problem and attempt a solution The Encyclopædia's definition may be condensed to read "A calendar is a method of meting out time into hours, days, etc, for ordinary use" It is therefore a table of measures which establishes certain units of time and defines the relations between them, and this must be so done as to facilitate the transaction of business

A fortunate solution must depend largely on the units employed and Professor Woolhouse gives, as he must, the *solar day* and the *solar year* as two natural and indispensable units, mentioning later the *month* as a natural but not indispensable one Owing to these units being natural, they are incommensurable and simplicity requires the smallest possible number of such units. It would therefore seem advisable to exclude the month from any controlling influence in the calendar.

Let us see how this will look in a more definite and practical form

Suppose that SCIENCE should found the

Calendar Betterment Association

to spread information and enlist interest and influence sufficient to secure the passage of a law something as follows, similar action to be urged in other countries

It is hereby enacted that the *calendar year* 1917 shall end and the *new-calendar year* 1918 shall begin at midnight of the thirtieth day of December, 1917

That a *new calendar* is hereby established requiring

That the years 1918 to 1924, inclusive, shall consist of fifty-two weeks of seven days each, thus giving these years the uniform length of 364 days

That during these seven years the twelve months shall be recognized in their customary order and grouped in the usual four seasons, but with a length of thirty days each for the first two months and thirty-one days for the last month of each quarter Each first month of a quarter will then begin with Monday, the second with Wednesday and the last with Friday, and all thirty first days will fall on Sunday

That the dates in existing legal papers, or future ones which may mention months, shall apply to the months of the new calendar, in which the first days of January, February, June, August, September and November will take the place of the suppressed thirty-first days of the preceding months

That the dates in all legal papers made under this new calendar shall be expressed by stating the day of the week, the number of the week and the year, the weeks being numbered in succession from the beginning thereof and the days of the week from one to seven, or named as usual, from Monday, the first day, to Sunday, the last. When the date is expressed in fractional form the numerator shall be the number, or name, of the day and the denominator that of the week, thus the first Tuesday in 1918 will be 2/1 1918 or Tu/1 1918, and the last Saturday 6/52 1918 or Sa/52 1918, and the date may be underscored when confusion might occur with an old calendar date For relatively unimportant purposes these dates may be written thus 20118 and 65218

That during the *common years* previous to 1925 the necessary adaptations of business procedure to the occurrence of *long years* of 53 weeks each shall be made

That as the year 1924 will end about the shortest day, and as certain of the calendar years must be lengthened to make their average the natural length, the year 1925, and every fifth year thereafter, shall be a *long year* of 53 weeks, with the exception of the year 1950 and subsequent years divisible by 50, which shall be common years

That for a still closer adjustment the years 1995, 2395, etc, at intervals of four hundred years shall be changed back to common years of 52 weeks each

That no further adjustment is to be anticipated for 25,000 years

That after 1/1 1925 all legal and business documents shall be dated by the day, week and year, and periods of time shall be stated in days, weeks and years, and that so stated a year shall be held to mean 52 weeks, and that when a year of 53 weeks is intended it must so be stated or the term "*long year*" used

It was my first intention to write a criticism of the calendar proposed in the letter referred to, but on a visit to an old friend shortly after its publication we discussed it and also my system, which he urged me to put in print. From the point of view of the writer of the letter, which my friend somewhat favored, the calendar he proposes has much to recommend it It is certainly picturesque, too much so for business purposes, but not enough for ecclesiastical If the definition of a calendar could be changed to make it a piece of tapestry to decorate the seasons, it might be acceptable in America with publishers of calendars and others on the ground that people here are too practical and lack in artistic feeling, and need something of the kind to educate them to appreciate the beauties of the church calendars, but business people want a plain calendar

After writing the above an accidental opening of your issue of December 23 shows me a similar proposition for correction by weeks from the University of Illinois, where for some years astronomy was in my charge, but the arrangements proposed bring to mind a passage in the Encyclopædia which says "The difficulties that arose in attempting to" adjust differences "induced some nations to abandon the moon altogether" Wise nations! To the escaping Hebrews the moonlight was all-important, but if we were to run away we should most likely depend on artificial light and may safely abandon the moon

A discussion in detail of the feasibility of the correction by weeks would be too long for a single letter My hope is that it may be exhaustively criticized and prove to be the easiest way One five-yearly correction large enough to be intelligently provided for ought to be better than numerous small and confusing irregularities

Comparatively such a correction is not large For the sake of uniformity we now have "standard time" varying as much as two per cent from local time, local noon varying as much as one per cent from astronomical, and we have months differing in length by ten per cent, with similarly large differences between the calendars of different nations The proposed correction is less than two per cent

Some of the details have been worked out in tabular form to the year 2006 and further, but this letter is long enough without the insertion of tables The general effect of the proposed calendar on New Year's Day is to shift it towards the shortest day of the year, but by 1946 and 1991 it has returned to its present place, after 1991, however, it creeps back more permanently so as to remain among the shortest days of the year

J Burkitt Webb

To the Editor of Science If calendar reform is going to be a subject of discussion in scientific circles, international conferences, etc, it would be well to bear in mind that any radical change will be a great inconvenience to the business world I agree with Professor Barton[1] that the disadvantages of Professor Chamberlin's scheme outweigh its advantages

We can not have an ideal calendar for the reason that 365 is not exactly divisible by 12, 10 or 8 The year has been divided into twelve months for thousands of years, and it is as satisfactory a division as can be made, especially since the twelve months are divisible into four quarters The chief objection to the present calendar is that February has only 28 days This can easily be changed by giving it 30, and taking the two days from some of the months that now have 31 I suggest the following

Five months of 31 days December, January, June, July, August—155 days

Seven months of 30 days February, March, April, May, September, October, November—210 days

February may be given 31 days in leap year

December, January and July each have now a national or general holiday We can shift Memorial Day to June and Labor Day to the last working day in August, so that each month of 31 days would have a holiday in it

Wm Kent

The movement for the reform of the calendar has just made new progress We learn from M Grosclaude, inventor of the chief project, and also by official confirmation through the newspapers, that the Swiss Federal Council has decided to initiate the calling of an international conference, whose purpose will be the reform of the Gregorian calendar, in order to obviate the inconvenience caused by the changing of the weeks in the year, which brings the school holidays at different times each year

The Vatican has been consulted and would be in favor of the reform, which would remove the necessity for changing the date of Easter every year

The reform to be discussed will be based on the project of Grosclaude, which has already been explained in these columns, and which was recommended by the first congress of the Universal Esperanto Association last August

It is therefore to be hoped that soon this important reform will be on the way to realization

[1] Science, January 13

If the Swiss government had not taken the initiative in the matter, the government of the Netherlands was and is yet willing to call a conference for the same purpose

During the past few months SCIENCE has devoted a great deal of space to the above subject, and several well-developed schemes for improving the calendar have been advanced However, none of these schemes has been complete, and none of the authors of them has presented with his scheme a plan by which it could be introduced

The above quotation is a translation from Esperanto of a news item which appeared in the issue for December 5, 1910, of the official organ of the Universal Esperanto Association, published at Geneva, Switzerland It speaks of a scheme for improvement of the calendar that has been under discussion in Europe for more than twenty-five years, but which, strange to say, has never been published in this country This plan was originally published anonymously by Camille Flammarian in 1884 and afterwards by M Armelin, of Paris, in 1887 In 1900 it was revived by L A Grosclaude, of Geneva, and it is known as Grosclaude's project It has been developed to its present stage by scientists of various nations in the *Internacia Scienca Revuo*, published in Dresden, by means of the language Esperanto In the recent discussion the original plan has been slightly modified in accordance with ideas advanced by Professor Dr W Koppen, of Hamburg, and the scheme as here presented is now advocated and supported by Dr Rene de Saussure, a well-known scientist of Geneva

As will be seen from the following explanation and the accompanying table, the compilers of this scheme have achieved a wonderful simplification of the Gregorian calendar, which can be introduced with absolutely no break in present dates and no interruption of present customs

There are just three great evils in the present calendar, and these are (1) The constant changing of the position of the weeks in the year, (2) the great irregularity and inequality of the lengths of the months, (3) the necessity for movable holidays on account of the changing of the weeks each year

As the third evil is caused by the first, there are really only two points which need to be changed in the present calendar These are (1) To fix the weeks in the year, and (2) to even up the lengths of the months

As there is just one day more than fifty-two full weeks in an ordinary calendar year, the obvious solution of the problem of the changing weeks is to make this day a non-week-day Having done this, the fifty-two weeks may be divided into four quarters of thirteen weeks each As each quarter has ninety-one days, it may be divided into three months—one of thirty-one days, and two of thirty days A little calculation demonstrates that the logical place for the thirty-one day month is at the beginning of the quarter, as this arrangement makes it unnecessary to change the length of more than five of the months, the other seven months remaining exactly as at present

By placing the non-week day at the end of the year, it may be made the thirty-first of December, thus remaining a part of the month and of the year, although not a part of any week

As the thirty-first of December is St Silvester's Day, and is celebrated quite extensively in some sections in Europe, it is proposed to call the non-week day *Silvester* and to make it the holiday, instead of January first as at present

As the first day of the week is Sunday, each quarter must begin on Sunday in order to have thirteen complete weeks in each quarter January first would therefore fall on Sunday, and "Silvester" would come between Saturday and Sunday

In leap years, the leap-year day would also be made a non-week day and would be placed at the end of the first half-year, thus becoming the thirty-first of June, and giving the first half year the same number of days as the second half It is proposed to call it *Leap-year Day*

This plan makes a peculiarly happy disposition of the holidays, movable, as well as fixed, as may be seen by the accompanying

table of fixed dates It combines all the best points of the proposals that have been published in these columns, and avoids their bad points

The plan for its adoption has all the simplicity that usually accompanies really good things and is as follows

In the year 1911, the days of the week in the months of September, October, November and December coincide with the arrangement in the proposed calendar If, any time during the year 1911, the governments of the various nations will decide to declare the thirty-first of December of that year, and of all future years, a non-week-day, one half of the problem will have been solved If they will then declare that during the year 1912, and all future years, the number of days in the five months February, March, April, May and August shall be changed in accordance with the accompanying table, the entire problem will have been solved

As this is a perfectly simple, practical and conservative plan for overcoming difficulties that every one is obliged to contend with every day of his life, steps should be taken by those in a position to do so, to have the president authorized to appoint a commission to investigate the matter thoroughly, with authority to confer with the similar commissions to be appointed by other governments and by the Vatican, to the end that some such scheme shall be adopted

The conditions necessary for the adoption of this scheme as outlined above will recur in 1917, and as it is hardly likely that any scheme can be agreed upon by December, 1911, we may look to that year to free us from the inconveniences under which we have suffered so long

JOHN M CLIFFORD, JR

BRADDOCK, PA

INVARIABLE TABLE OF DATES

For the Quarters

Days	Months														
	January April July October					February May August November					March June September December				
Sunday	1	8	15	22	29		5	12	19	26		3	10	17	24
Monday	2	9	16	23	30		6	13	20	27		4	11	18	25
Tuesday	3	10	17	24	31		7	14	21	28		5	12	19	26
Wednesday	4	11	18	25		1	8	15	22	29		6	13	20	27
Thursday	5	12	19	26		2	9	16	23	30		7	14	21	28
Friday	6	13	20	27		3	10	17	24		1	8	15	22	29
Saturday	7	14	21	28		4	11	18	25		2	9	16	23	30
Non-week day[1]															31

[1] Only in December of ordinary years and also in June of leap years

QUOTATIONS

THE GOVERNMENT OF UNIVERSITIES

AMERICANS interested in the questions of university government will find much that is interesting and pertinent to our own situation in the admirable article on "Modern Universities and their Government" which is the leading feature of the London *Times's* educational supplement for April 4 We are very much in the habit of thinking of our universities, with ultimate power over the institution resting in the lay boards of trustees, as being in this respect quite unlike any other educational institutions of similar importance, and this is natural enough, since the half-dozen new universities that have been established in the chief provincial cities of England, and which are probably their only important analogues, are of such recent origin as to be seldom prominently in our thoughts in this connection It is the government of these new universities, and especially the methods and the spirit of their procedure in the appointment of professors, that constitute the subject of the *Times* article, a subject justifying the extreme seriousness with which it is discussed because the universities in question are expanding with such rapidity that they "have to a large extent the future of English learning in their hands"

Both the resemblances and the differences that suggest themselves, as between the American and the English experience, are of decided interest Into the details of the English organization we shall not attempt to enter, suffice it to say that the active governing authority of the university, corresponding to our board of trustees, is what is known as the council, and while this council is not nominally self-electing or self-renewing, in practise it is so Perhaps the most interesting state-

ment made about the councils is that which refers to the personal attitude of the members who constituted those bodies in the first place, and to the signs of a change which seems to be more or less in danger of showing itself as matters settle down to a more mechanical routine. The large prospect of creative utility which the foundation of the provincial universities opened up attracted the services in their councils of some of the ablest business men in England, who felt that they were privileged to take part in the building of great institutions of national importance. "And, being large-minded men," says the *Times* writer, "they have usually recognized the limits of their own competence, and know what matters to leave in the hands of the experts. They have respected and trusted the scholars by whose presence their cities were enriched." In some of the successors of these large-minded men, a tendency has been observed to depart from this fine attitude. "The smaller man is apt to have less respect for and less trust in the scholar than the bigger man, and a more serene confidence in his own capacity as a 'business man' to deal wisely with any and every question that may come before him."

Speaking broadly, it is safe to say that while our boards of trustees have furnished illustrations of both of these types of attitude and conduct, neither their merits nor their defects have been so pronounced as the *Times* article represents to be the case in England. Many trustees of American universities, however, have done a great amount of important and unselfish service, animated by that same feeling of the honor and the usefulness of their posts as obtained with the able men who helped to build up the new English universities, while, on the other hand, the instances of pretentious or ignorant meddling by trustees have been very rare in this country, in the case of universities of high standing and importance. But this abstention from harmful interference on their part has been accompanied, in most cases, by that abnormal concentration of power in the hands of the university president which has formed so prominent a subject of recent academic controversy.

It is a notable circumstance that, varied as are the methods of selection discussed in the *Times* article, there is not a word of discussion as to the tenure of the professor after appointment. That a professorship should be a life position it does not seem to occur to any one to question. The defects that exist in regard to the matter relate entirely to the way in which the selection is made. In this respect great differences exist, some of the university councils proceeding upon exceedingly crude "business" notions of the way in which the best man is to be found, while others have established methods that are, in the opinion of the *Times* writer, the best that could possibly be devised. In these cases, the most careful inquiry is instituted, in the first instance, by a committee of the particular faculty concerned, an inquiry which results in the adoption of different methods—including, when necessary, that of advertisement—according to circumstances, the senate considers the result of this inquiry, and then makes its recommendation of a particular person to the council, giving "a full and reasoned statement" of the grounds for its choice. Of course, this recommendation is usually adopted without question, but the process, with a council of the right sort, is evidently a wholesome one. It is not altogether different from that obtaining in some of our own universities, but what strikes one in reading of it is the profound realization of the importance of making the best possible choice. This, as well as the permanency of tenure, is sure to have a powerful influence in the preservation of the ideas of dignity and importance which ought to attach to the post of a university professor, and it is evident that in England as well as with us much will depend on the vigor with which, now and in the near future, those ideas are insisted on by the public opinion in the educational world. "Lay hands suddenly on no man," but, having chosen him, let him feel that his position is assured—this is the rule that must guide in professorial appointments if we are to get the maximum of that real

university efficiency which can not be measured by any mechanical tests, but which has its root in the personality of the professors —*The New York Evening Post*

SCIENTIFIC BOOKS

A Directory of American Museums Compiled by PAUL MARSHALL REA Being No 1, Volume X, Bulletin of the Buffalo Society of Natural Sciences 8vo, pp 360 Buffalo, N Y 1910

The object of this directory is to give, as far as possible, a complete list of the museums of America, using the word in its broad sense, with information as to their purposes, character and extent of their collections, mode of support, manner of administration, staff and publications, with a brief sketch of the history of each institution It is arranged alphabetically by states and cities, and, with the index, comprises 360 pages, 313 being devoted to the museums of the United States The collections are listed mainly under certain specified headings, anthropology, art, botany, geology, paleontology, zoology, and the approximate number of specimens on exhibition and in the study series is stated Great pains have been taken to have this information as exact as possible, and it will be found that in many cases there is a very considerable reduction in the size of collections from that noted in the list prepared by F J H Merrill and that in a few instances there is stated to be "no museum," where one was said to exist in 1903

The data given, checked by the character of the financial support, and a knowledge of the staff, will furnish a pretty good idea of the size and importance of the institutions noted

The preparation of the work was authorized in 1908 at the second meeting of the Association of American Museums and the arduous duty of gathering the information and making it ready for publication was performed by Paul M Rea, secretary of the association The cost of issuing the work, which has been considerable, was generously borne by the Buffalo Society of Natural Sciences It was hoped to have had the directory issued as a memorial of the Buffalo meeting of the association, but owing to inevitable delays in securing needed information it did not appear until late in 1910

As the only directory of American museums previously issued is that prepared by F J H Merrill and published in 1903, by the education department, state of New York, this volume is very welcome We should have been glad of a brief summary, giving the number of museums in the United States, their total annual expenditure and the number of their staff, but this may well be left for some one interested in the study of statistics

In conclusion it may be said that if, as Dr Goode considered, the museum is the most advanced of institutions for the education of the public the United States stands well to the fore F A LUCAS

Studies on the Structure and Affinities of Cretaceous Plants By MARIE C STOPES and K FUJII Phil Trans Roy Soc, London, Series B, Vol 201, 1910, pp 1–90, pls 1–9

A glance at the above somewhat impressive title might lead one to presume that we have to do with a paper of broad, possibly worldwide, scope, and it is not until we reach page 4 that we learn incidentally that it deals exclusively with material from Hokkaido, northern Japan Here the authors have been exceedingly fortunate in securing nodules—presumably silicified—in which are preserved fragments of vegetation which indicate the presence of a varied and interesting flora, and suggest, in the manner of occurrence, the English Carboniferous nodules which have yielded such splendid results to Williamson, Scott and others It is much to be regretted, however, that the present paper does not give more explicit information regarding the geological position of the material, the only data on this point consisting of the following statement "In nearly every case there are parts of shells of Ammonites in the nodules These have been described by Yabe, and there is no doubt, as a consequence, that the plants are of Cretaceous age" That the description of the

Ammonites by Yabe necessarily proves the Cretaceous age of the plants may, or may not, be true, but it can hardly be accepted as very definite information in itself, since Ammonites had their origin in the Triassic. Even if they are located in the Cretaceous or "Upper Cretaceous" it is not sufficiently close to permit of comparison with horizons of definite stratigraphic positions in the Cretaceous of other parts of the world. But this study avowedly was made, not from the standpoint of geological paleobotany, but from the professedly higher plane of histology, and as such it must be judged.

Those paleobotanists who, although perhaps not entirely without knowledge or appreciation of the value of structure, have made widest use of the impressions of plants, have had held before them the dictum that structure is the only road that leads to permanent accomplishment—a sort of Nirvana, as it were, which few could hope to attain. It was therefore with particular pleasure that we turned to the present paper in the hope that we should find an exposition of paleobotany founded on the solid basis of internal structure. The reviewer confesses to a feeling of disappointment.

Of the eighteen new genera and species, which range from fungi to angiosperms, it appears that hardly any is of absolutely definite position and affinity. Thus, of the fungus (*Pterosphæria*) our authors say, "the lack of characteristic spore-bearing fructifications makes its exact location impossible." Of the two forms described as ferns, the first (*Schizæopteris*) is thought to belong to the Schizæaceæ, but its affinity is uncertain, while the other (*Fasciostelopteris*) is balanced between the Cyatheaceæ, Marattiaceæ and Dicksoniaceæ, and the conclusion is reached it "may therefore for the present be provisionally included in the Dicksoniaceæ." *Nipponophyllum cordaitiforme* is a leaf, and here now is the opportunity to see what can be done with internal structure as compared with an impression. After meandering through the better part of five quarto pages in seeking affinities balanced between Araucarineæ, Podocarpineæ, various genera of cycads, as well as *Cordaites*, we have the following: "Was the plant to which our leaf belonged a primitive type of cycad, or perchance a belated, small-leaved *Cordaites* surviving in this island of the orient, just as the truly archaic *Ginkgo* survived to the present geological epoch?" Since *Cordaites* had its maximum development in the Carboniferous and did not, so far as we definitely know, survive beyond the close of the Paleozoic, this discovery is of interest—if true! Their new species of *Cedroxylon* might belong, they state, either to this genus or to *Cupressinoxylon*, while the "new" coniferous genera *Yezonia* and *Cryptomeriopsis* have recently been reviewed at length by Professor Jeffrey.[1] The Anglo-Japanese authors state of their *Yezonia*: "It is impossible to find any family among gymnosperms with which we can satisfactorily include this plant," but Jeffrey shows conclusively that it is the same as *Brachyphyllum* from the Cretaceous of Staten Island, adding "if all the points of agreement between the description of the supposed new genus *Yezonia* ... and the account of the anatomy and habit of *Brachyphyllum*, given in the present article and in the large memoir of Dr. Hollick and the present author were italicized, it would be necessary to italicize the whole description"! Their *Cryptomeriopsis* is shown by Jeffrey to be merely the old *Geinitzia* (*Sequoia*) *Reichenbachi*, that has been known from impressions since 1842.

The several angiosperms described are, if possible, in an even more unsatisfactory state as regards definiteness, and the authors acknowledge that "from the anatomy of stem and rootlets alone it is a matter of extreme difficulty and some uncertainty to determine the affinity of an angiosperm." Thus of their *Jugloxylon* they "lay no particular stress on the systematic position that the name suggests." *Populocaulis* agrees with *Populus* "more closely than with any other," while *Fagoxylon* has "general affinities with the whole Cupuliferæ," which is certainly sufficient leeway. The only angiospermic fructifi-

[1] *Annals of Botany*, Vol. 24, 1910, p. 767.

cation that came to light our authors had some difficulty in placing, finding it hard to decide whether it belonged to the dicotyledons or monocotyledons, but as a final conclusion they say "On the whole, judging from its detailed structure and general appearance, we incline to place the flower in the Liliaceæ" Is it to be presumed that such adumbrations as the above add much to the evolutionary history of the Liliaceæ, or of the monocotyledons in general?

It is not necessary to further mention the technical portion of the paper, and it only remains to call attention to some of the nomenclatorial anomalies All the genera and species published as new to science in the present paper were printed a year earlier in the *Geological Magazine*, London, N S, Vol 6, 1909, pp 557–559, but without characterization They are all again listed on page 1 of the paper under review, some of them incidentally mentioned at various places in the introduction, each again appearing at the head of the section of the text in which it is described, while at the end of the description there is a formal generic and specific characterization where each is called "gen nov," or "sp nov" The question arises as to how these shall be cited To give *Cryptomeriopsis* as a concrete example Shall we quote page 1 of this paper, where it is first printed; page 3, where it is mentioned and partially described, page 52, where it stands at the head of the description, or page 57, where the genus and species are formally dedicated?

The reviewer does not wish to be understood as in any way underestimating the value of histology in establishing a firm basis on which to work out the developmental history of plants, but if the study of the internal structure of fossil plants, as contrasted with the study of plant impressions, is to be given proper weight it must be subject to the same scrutiny If the study of the intimate anatomy of fossil plants leads only to indefiniteness and inconclusion, it is not entitled to greater weight than attaches to the study of the impressions of plants

F H. Knowlton

SOME RECENT ADVANCES IN FLUORESCENCE AND PHOSPHORESCENCE[1]

After an opening period of great activity, which began with Becquerel, Herschel and Stokes and included the important work of Lommel, Wiedemann and Schmidt and of numerous other physicists, there was a long time of comparative quiescence during which *luminescence,* to use the word proposed by E Wiedemann, was a neglected branch of optics Quite recently there has been renewed activity in this field and it is of some aspects of this newer work that I shall try to give a brief account No approach to a complete summary can be made in a single paper and I shall deal chiefly with certain investigations which are particularly suggestive of the beginnings of correlation in this involved and obscure portion of the science of radiation

The Relations of Phosphorescence to Fluorescence —The common view that phosphorescence is simply what remains of fluorescence after the cessation of excitation would seem to need essential modification according to the latest paper of Lenard,[2] who, after extending his observations to some fifty phosphorescent compounds, made by the addition of a trace of some metallic salt to a sulphide of strontium, barium or calcium and certain heat treatment with a flux, considers that it is necessary to distinguish two phenomena, the one temporary, which ceases almost instantly after the end of excitation (*Momentan-process*), and the phenomenon of long-time phosphorescence (*Dauer-process*) The distinction is three fold · The momentary process may be produced independently of the other (1) by very brief excitation, (2) it may be excited by the use of portions of the ultra-violet spectrum which are incapable of producing long time phosphorescence or (3) at temperatures above or below the range within which long-time phospho-

[1] Abstract of a paper presented before Section B at the Minneapolis meeting of the American Association for the Advancement of Science

[2] Lenard, *Annalen der Physik* (4), Vol XXXI., p 641, 1910

rescence can be excited Lenard regards the phosphorescence spectrum as consisting of one or more well-separated, broad and continuous bands usually lying within the visible spectrum Detailed study of these bands with the spectrophotometer,[3] however, shows that they are really of a very complex structure and consist of overlapping components which can not be separated altogether for any given temperature or mode of excitation, but which are so differently affected when the wave-length of the exciting light is varied or when excitation occurs at different temperatures, as to indicate that they are not due to the luminescence of one and the same molecule or aggregate It is probably on account of this complexity of the phenomena that Lenard has reached his view of the case Certainly the evidence of recent work by Pierce,[4] Waggoner[5] and Zeller[6] goes to show that whatever may be true of phosphorescent sulphides prepared by the method of Lenard and Klatt, the relation between phosphorescence and fluorescence is in many other instances the intimate one that has usually been assumed to exist

Fluorescence in the Ultra-Violet and the Infra-Red—Stark and Meyer[7] have in a recent paper shown the existence of numerous fluorescence bands lying in the ultra-violet spectrum In the case of the benzol derivatives with which their measurements have to do fluorescence depends for its position upon the complexity of the molecule and it is found that, as a rule, the heavier aggregations have bands in the longer wave-lengths

Steubing[8] finds spectrum lying at still shorter wave-lengths (.1884μ) which he ascribes to the fluorescence of oxygen This spectrum, like the corresponding spectra for vapors of gases having fluorescence in the visible spectrum, as described by Wood,[9] consists of a group of bands regularly but not uni-

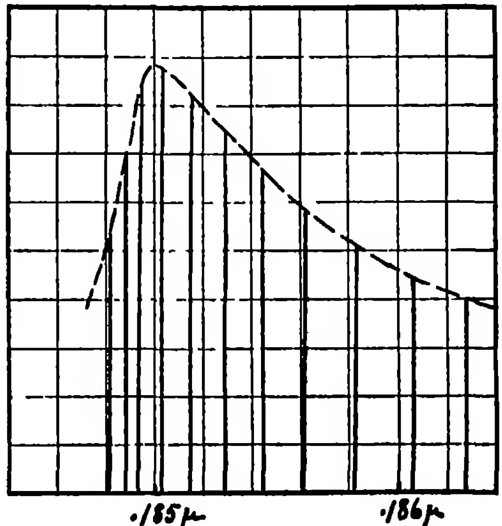

FIG 1 Diagram showing the distribution and relative intensity of bands in the fluorescence spectrum of oxygen (Steubing)

formly spaced As may be seen in Fig 1 the distance between the bands increases gradually with increasing wave-length Beginning at that end of the group which lies furthest in the ultra-violet, the intensity of the individual bands rises very rapidly to a well-marked maximum and falls off more slowly as the wave-length increases An inspection of the remarkable photographs made by Wood of the fluorescence of sodium and other vapors leads one to believe that were measurements made of those spectra a similar distribution of intensities would be found to exist.

Pauli[10] has recently subjected the preparations of Lenard and Klatt to systematic study, particularly with the view of corroborating Lenard's hypothesis that the active metallic atom embedded in the sulphide is to be re-

[3] Nichols and Merritt, *Physical Review*, Vol XXXII, p 38

[4] Pierce, C A, *Physical Review*, Vol XXVI, pp. 312 and 454, XXX, p 663

[5] Waggoner, C. W, *Physical Review*, Vol XXX, p 663

[6] Zeller, C A, *Physical Review*, Vol XXXI, p. 367

[7] Stark and Meyer, *Physikalische Zeitschrift*, Vol 8, p 250

[8] Steubing, *Annalen der Physik* (4), Vol XXXIII, p 553, 1910

[9] Wood, *Philosophical Magazine* (6), Vol X, p 513, Vol XV, p 581, Vol XVI., p 184

[10] Pauli, *Physikalische Zeitschrift*, Vol XI, p. 991.

garded as an electric oscillator, the period of vibration of which depends upon inductance and capacity. By modifying the dielectric constant of the solvent it was found that the position of the fluorescence band could be altered at will and Pauli succeeded in producing preparations having bands in the ultra-violet only and in other cases only in the infra-red.

The Complexity of the Fluorescence Spectra of Solids.—The complexity of fluorescence spectra which was first so strikingly exhibited in Wood's studies of sodium vapor is by no means confined to gases. Not only do we have solids whose spectra are made up of overlapping bands due to the presence of several fluorescing constituents, as in the case of the sulphides of Lenard and Klatt, but there are also substances of definite chemical composition, notably the uranyl salts, the fluorescence spectra of which consist of a group of several bands arranged in a manner which suggests the banded spectra of gases. E. Becquerel[11] in 1872 studied these fluorescence bands and discussed their relations to the corresponding absorption spectra. The subject has since received the attention of numerous investigators, the most recent contribution being that of Jones and Strong.[12] Henri and Jean Becquerel,[13] working at Leiden with Kamerlingh Onnes, have studied the fluorescence spectra of uranyl salts, photographing the same at 288° of the absolute scale, 80° (liquid air), 20° (liquid hydrogen) and 14° (solid hydrogen). Under these conditions the already unusually narrow bands are reduced to mere lines in the spectrum and each band is found to consist of a group of such lines.

The relation of the narrow fluorescence bands of the uranyl salts to the broad bands in the fluorescence spectra of other solids and liquids is not at first sight obvious. They appear to be intermediate between the broad bands usual to solids, of which sometimes only one exists, and the complicated groups of lines observed in the case of vapors. Some recent studies of the uranyl bands appear, however, to throw some light on this relationship.[14] Hitherto attention has chiefly been directed to the location of the bands in the spectrum. When, however, we measure the relative intensities of such a group of bands we find them to be related in a very interesting manner. The curve showing the relation between wave-length and intensity of the seven strongest bands in the fluorescence spectrum of such a salt has a form which is essentially identical with that of the typical curve for the distribution of energy in the broad single bands of ordinary fluorescence spectra. The shape is the same for the various uranyl salts, being shifted slightly in wave-length with the chemical composition or with the presence or absence of water of crystallization.

Fig. 2 will serve to indicate the characteristic form of these curves and the shift

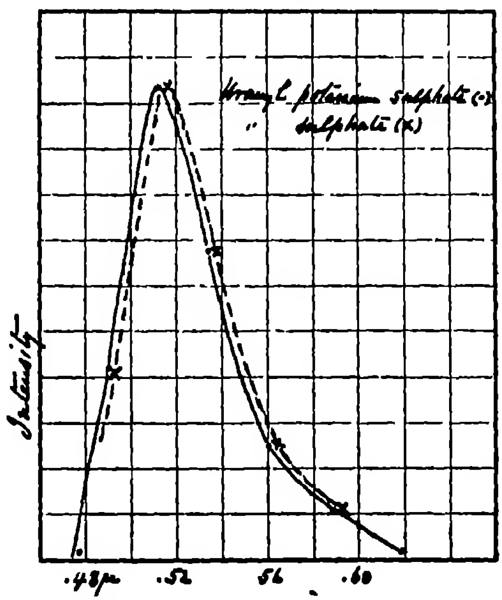

FIG. 2. Relative intensities of the seven principal bands in the spectra of two uranyl salts.

[11] E. Becquerel, *Mémoires de l'Académie des Sciences*, XL., 1872.

[12] Jones and Strong, *American Chemical Journal*, XLIII., p. 37.

[13] H. and J. Becquerel and Onnes, "Leiden Communications," No. 110.

[14] Nichols and Merritt, "On the Fluorescence Spectra of the Uranyl Salts and on the Structure of Fluorescence Bands in General." A paper presented at the Minneapolis meeting of the American Physical Society, December 28, 1910.

due to change in chemical composition The examples selected are uranyl sulphate ($UO_2SO_4\ 3H_2O$) and uranyl potassium sulphate ($UO_2SO_4\ K_2SO_4\ 2H_2O$)

That this relation is not an accidental one, but that these various bands are probably due to the oscillations of one and the same complex mechanism may be almost conclusively established by observing the spectrum under various conditions of excitation and of temperature When we subject accidental combinations due to different substances in a fluorescing mixture to such changes the independence of the various components is readily shown, but in the case of the uranyl bands when excited by the monochromatic light of various lines of the mercury arc from 4538μ to 2536μ it is found that the relation between the intensities of individual bands remains very nearly the same When the substance is gradually cooled to the temperature of liquid air and observations are made at intermediate temperatures, it is found that all of the bands shift towards the violet and that their gradual movement as the temperature changes is of the same character for all The relation of intensities in this case does not remain the same, but it is significant that the changes are such as to produce a modification in the curve of relative intensities precisely similar to that which is known to occur in the case of the ordinary broad continuous fluorescence bands when the excited substance is cooled It would therefore appear that we have in the case of the fluorescence of the uranyl compounds a single fluorescence band of the usual type but broken up into several easily separable components It is easy to imagine that a continuance of the change which occurs in the fluorescence of these substances as the temperature rises from that of liquid air to $+20°$ C would result in the merging of these components into a continuous band in which they could no longer be distinguished from one another

In the case of some of the uranyl salts, indeed, the overlapping of the bands is considerable under ordinary conditions, as may be seen in Fig. 3, which is from measurements of the three strongest bands of uranyl nitrate at 20° C

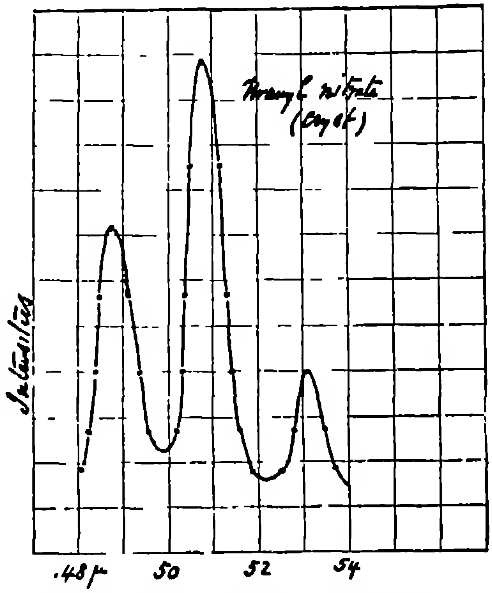

FIG 3 Diagram showing the overlapping of the three principal bands in the fluorescence spectrum of uranyl sulphate

The relation may be carried still further when we consider that the broad continuous bands of fluorescent substances are always associated with a broad absorption band usually overlapping the fluorescence band on the side toward the violet and that the absorption spectrum of the uranyl salts consists of a series of bands precisely similar as regards their arrangement and number to the bands of the fluorescence spectrum This group of bands according to E Becquerel is to be regarded as a continuation of the series of fluorescence bands It has been shown by H. and J Becquerel and Onnes[18] to overlap the group of fluorescence bands According to their photographs the bands nearest the red in the absorption group when observed at the temperature of liquid air are nearly if not quite coincident with the last ones of the fluorescence group towards the violet

As in the case of the fluorescence bands of the uranyl salts, the absorption bands increase

[18] Becquerel and Onnes, *l c*

in intensity as we pass from either end towards the middle of the group, and we may depict the relation of the two groups by drawing the enveloping curve for the region of absorption and for that of fluorescence and showing the extent to which they overlap, as in Fig. 4. While detailed quantitative studies of the absorption bands have not yet been made, the preliminary observations indicate that the enveloping curve is an "image" of that of the group of fluorescence bands, just as the broad absorption band of resorufin and other fluorescent substances has already been shown[18] to be the overlapping image of the corresponding fluorescence band.

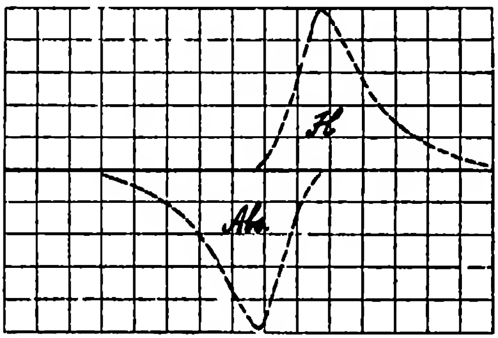

FIG. 4. Diagram showing the overlapping of fluorescence and absorption in the case of a uranyl salt.

Not only is the envelope of the fluorescence group of the same type as the curve of distribution of energy in ordinary fluorescence bands, but each component, as has been shown by spectrophotometric measurements, has a similar distribution of energy. Moreover, both curves have the same characteristics, although with very different scales of wave-length, as the energy curve of the temperature radiation of a black body. That the relation between the luminescence of solids and liquids and that of vapors is an intimate one is strongly suggested by the comparison of the diagram from Steubing's measurements of the fluorescence of oxygen (Fig. 1) with the curves for the uranyl salts just described, and this suggestion is strengthened by the inspection of Wood's curves for the fluorescence of sodium vapor. Moreover, the family resemblance of all these related cases of banded fluorescence spectra to the banded spectra of gases as we find them described in the papers of Deslandres and of Kayser and Runge is unmistakable. In view of these numerous indications of a common property may we not anticipate the attainment of some broader generalization concerning the various types of radiation than has hitherto been made?

E. L. NICHOLS

[18] Nichols and Merritt, *Physical Review*, Vol. XXXI., p. 376.

NOTES ON THE PRELIMINARY REPORT OF THE COMMITTEE ON THE TEACHING OF MATHEMATICS TO STUDENTS OF ENGINEERING

AT the meeting of the Society for the Promotion of Engineering Education held at Madison, Wis., in June, 1910, the members present were handed sets of galley proofs of the Preliminary Report of the Committee on the Teaching of Mathematics to Students of Engineering, which committee was appointed at a joint meeting of the American Mathematical Society and Sections A and D of the American Association for the Advancement of Science in December, 1907. The committee consists of twenty members, ten of them being professors of mathematics, three presidents of technical institutions and seven professors of engineering and consulting engineers.

The report being only a preliminary one, it is subject to amendment before being presented as a final report, and no doubt the members of the committee will be glad to receive any suggestions which will tend to make the report more useful and more acceptable to engineering teachers. The writer acknowledges the great value of the report as a whole, but he has some criticisms to offer on one portion of it, viz., elementary dynamics, which he hopes will be carefully considered by the members of the committee and by others interested, who may be led by it to offer the committee additional suggestions.

In the preface to the report it is said:

The defects in the mathematical training of the student of engineering appear to be largely in knowledge and grasp of fundamental principles,

and the constant effort of the teacher should be to ground the student thoroughly in these fundamentals, which are too often lost sight of in a mass of details

The defects mentioned are universally admitted and complained of, and they are perhaps more apparent in the subject of elementary dynamics than in any branch of pure mathematics, but the writer is of the opinion that they are due rather to the text-books than to the teachers As the committee says "What is most needed at the present time is a series of synoptical text-books which shall present in compact form (1) the fundamental principles of the science, and (2) a classified and graded collection of problems"

The writer heartily commends the two following sentences in the report

> The poundal is never used in practise, and no instruments are on the market which give readings in poundals, it should be dropped from the text books The so called "engineers' units of mass," namely, the G kilogram, or "metric slugg," and the g pound, or "slugg," are never used in practise, and no set of weights is on the market giving readings in terms of these units, they should be dropped from the text books

The chief trouble with the text-books is due to the fact that some early writer, in his attempt to overcome what he conceived to be a difficulty in teaching the subjects of weight and mass, invented the "poundal," and others invented the "engineers' unit of mass," "gee-pound" or "slugg" (32 2 pounds of matter), to overcome the imaginary difficulty, and other text-book writers blindly followed them These devices did not overcome the difficulty, but on the contrary only created confusion, and students had to spend weary hours on these worse than useless units, which afterwards, when they became engineers, they had to unlearn.

The idea of the "poundal" is probably a development of the "C G S" system, in which 1 dyne (force) acting on 1 gram (matter) free to move, for 1 second, gives it a velocity of 1 centimeter per second. In English units, if 1 pound force acts for one second on 1 pound of matter, the velocity at the end of the time is 32 2 feet per second If the English system only had either a unit of force = 1/32 2 pound, or a unit of quantity of matter = 32 2 pounds, then the figure 32 2 in the equation of the relation of force to acquired velocity would disappear, and the equation would look simpler, so the two new units, poundal and gee-pound, were invented, to the confusion of the subject, and they now have to be expunged from the language

Merely getting rid of the poundal and the gee-pound, however, does not get rid of the whole trouble arising from the use of the same unit, pound, to express both a force and a quantity of matter The committee (or perhaps only one or two members of it, to whom were assigned the subject of dynamics) have wrestled with the problem, but in the writer's opinion they have failed to find the best solution of it

In order to make this criticism as clear as possible, the following extracts are first made from the committee's report, and comments on the several paragraphs follow

Extracts from the Report

(*a*) The most important mechanical quantities for engineering purposes are length, time, angle and force Derived from these are area, volume, pressure, linear velocity, etc

(*b*) Less important for the engineer, but of great importance in general scientific work, is the quantity called "mass" (galley 39)

(*c*) The units of mass are of little importance to the engineer, since the quantity that enters into the equations of engineering is not the mass of the body, in units of mass, but its normal weight, in units of force

(*d*) The mass of a body may be thought of, roughly, as the amount of matter in a body (galley 40)

(*e*) The ratio W/g for a given body is constant in all localities This quantity, or a quantity proportional to this ratio, is called the *mass*, m, of the body (galley 35).

(*f*) The weight, W, of a body, at a given place, is the force that causes it to fall when unsupported (galley 34).

(*g*) If the mass of a body is one pound

(mass) then its normal weight is one pound (force) (galley 35)

(*h*) The normal weight, W_o, of a body is its weight in vacuo, at sea level in latitude 45°.

(*i*) A "set of standard weights" is a set of metal pieces each of which is marked with its normal weight

(*j*) The process of weighing a body on an equal arm balance, against a set of standard weights, gives the normal weight of the body

(*k*) The process of weighing a body on a *spring balance*, on the other hand, gives the *local weight* of the body

(*l*) To graduate the scale of a spring balance find the local weight of a set of standard weights as just explained (by computation from the value of g at the locality in question) and then suspend the pieces successively on the spring, and mark on the scale the deflection caused by the local weight of each piece (galley 34)

(*m*) Force may be thought of, roughly, as a push or a pull

(*n*) $F/W = A/g$ is taken as the fundamental equation

(*o*) If in the fundamental equation $F/W = A/g$ we substitute the equation for mass, $m = c(W/g)$, where c is the numerical factor depending on the choice of units, we have $cF = mA$ Any system of units which makes $c = 1$ in this equation is called an absolute system of units

(*p*) The equation $F = mA$ will give incorrect results if the forces and masses are given in any but absolute units In particular it should never be used in the ordinary problems of engineering

(*q*) On account of the special character of this equation $F = mA$ it is unfortunate that it should be so often taken as the fundamental equation of dynamics instead of the general equation $F/W = A/g$ from which it is derived (galley 41)

Comments on the above Extracts

(*a*) For "length, time, angle and force," we would better read "space, time, matter and force" Mechanics is the science of the action of force upon matter. Matter is that upon which force acts, and it is just as important as force in most engineering problems Matter occupies space, therefore space is one of the four elementary concepts of mechanics Length is merely the linear measurement of space in one direction, and therefore it should be placed in the list of derived quantities, with area and volume Angle should also be placed in the list of derived quantities, it is the difference in direction of two lines that meet in a point, or the difference in position of a line that is rotated a certain distance about one of its ends

(*b, c*) If "the quantity called mass" is the quantity of matter in a body, then this statement is incorrect The quantity of matter in a body is of the utmost importance to the engineer, independent of the force of gravity acting upon it, if the body is to be moved horizontally, or rotated, or accelerated, or if he or his client has to pay for it

(*d, e*) Here are two definitions of "mass" which are inconsistent If mass is the quantity of matter, why should it be "thought of, roughly"? Why is it not defined with precision as the quantity of matter as determined accurately by weighing it on an even balance scale and compared with the standard pound (or kilogram)?

The second definition is the ratio W/g, or a quantity proportional to this ratio

The fact is that the word "mass," as applied to matter, is used in three different senses

1 As synonymous with "portion," "piece" or "lump" of matter, as in the expression "this mass weighs ten pounds," the words "weighs ten pounds" referring to the quantity of matter as determined by weighing

2. As synonymous with the word "weight" (quantity of matter), as the word weight is universally used in ordinary language, and nine times out of ten by the engineer, who rarely uses the word "mass" in this sense Example: "This lump has a mass of ten pounds."

3. As synonymous with the ratio W/g, where either W is the weight (quantity of matter) and g is 32 174, the acceleration due

to gravity at the sea level at latitude 45°, or W is the force with which gravity attracts the body at any given place and g is the acceleration due to gravity at that place The quantity or ratio W/g is constant in either case In this the mass of the ten-pound lump is 10/32 174, and since it is a ratio it has no unit The statement that "the engineers' unit of mass is 32 2 pounds," found in some books on physics, is *incorrect* The engineer has no such unit

Giving the name "mass" to the ratio W/g was perhaps unfortunate, but it can not now be helped since it is universally used in this sense in the engineering text-books of the past sixty years or more It is a handy term, and the use of the single letter M instead of the fraction W/g often simplifies calculations It is hard enough to get rid of a bad term, for example, "poundal," which has been in the high-school books on physics for the past thirty years in spite of the numerous attacks upon it It is not likely that we can get rid of the term mass, M, in the sense of W/g unless some one invents another and a better name for it

Of course confusion results from the three different meanings given to the same word "mass," but the confusion arises chiefly from its use in the second sense given above, as synonymous with weight (quantity of matter) It is so used in all the books on physics, but as already stated, is rarely so used by engineers It would tend to diminish the confusion if the books on physics mentioned that in engineering "mass" means the ratio W/g, and not the quantity of matter in pounds, thus preparing students for what they will afterwards learn in their engineering studies

(*f*) "The weight, W, of a body, at a given place, is the force that causes it to fall if unsupported"

The word "weight" is used in two senses (1) in the sense given in the above definition, which is that of the text-books on physics, and (2) in the sense of quantity of matter as determined by the common method of weighing it In this sense it is used universally in ordinary literature and in commercial transactions, and nine times out of ten by engineers, in all calculations in which quantity of matter is involved

In this sense W is a constant quantity, in the first sense it is inconstant, varying with the latitude and with the elevation above the sea level

In the second sense, quantity of matter, the word weight was used long before Newton's time It is thus used in the clause of the constitution of the United States that authorizes congress to fix the standard of weights and measures, in acts of congress establishing the Bureau of Weights and Measures, and in acts of the British parliament It is thus used in the King James version of the English Bible "And they shall eat bread by weight" (Ezek 4 16) It is not conceivable that this meaning of the word "weight" can ever go out of use It is in the language of the people and it is there to stay

The beginning of confusion in the minds of students as to the meaning of the words "weight" and "mass" results from the fact that the high-school text-books use the word mass for what is commonly called weight, and attempt to restrict the word weight to mean only the force with which a body is attracted by gravity at a given place

(*g*, *h*) "If the mass of a body is one pound (mass) then its normal weight is one pound (force)"

By mass we here understand quantity of matter, and not the ratio W/g given in definition (*e*)

The "normal weight" (this appears to be a new and useless term, and therefore undesirable) is the force with which a body is attracted to the earth by gravity at latitude 45°.

If the sentence (*g*) were made to read "If the weight of a body is one pound, then the force with which gravity attracts it at the sea level in latitude 45° is one pound," it would be strictly accurate, in harmony with the every-day use of the language, and would avoid the confusion arising from the use of the word "mass" The meaning of the word "weight" in this sentence is not ambiguous

or doubtful It means both that the quantity of matter will balance the standard pound on an equal arm balance, and that the force which gravity exerts on it at latitude 45° is one pound, as indicated by a properly graduated spring balance

(*i*, *j*) If for the words "normal weight" in these two sentences we use simply the word weight, it will express the idea accurately, whether the word means quantity of matter or the force with which gravity would act on the body at latitude 45° The two meanings are synonymous and the two quantities identical The measure of the quantity of matter in a body is the measure of the force with which gravity attracts it at latitude 45°

(*k*) The process of weighing a body on a spring balance, on the other hand, gives the "local weight" of a body The term "local weight" also appears to be new, but as it strictly expresses the idea of the attraction of gravitation on a body at a given locality, and there is no other short term that so clearly expresses it, it may be considered unobjectionable The words "gravity of a body" might properly be used to express the idea, if text-book writers would agree to it, for its value would vary in the same proportion as the earth's gravitational force varies, with the locality.

The sentence (*k*), however, is true only if the spring balance has been graduated with standard weights at latitude 45° If graduated with standard weights at the locality (other than lat 45°) where the weighing is done, it will give the "normal weight," or quantity of matter, just as an even balance would do

(*l*) This sentence is not clear A spring balance graduated, say, at latitude 30°, by hanging on it successively the standard weights, 1, 2, 3, 4, etc, pounds, and marking the deflection shown by each, will show at latitude 30° the weight (quantity of matter) of bodies weighed on it, but if it is desired that the balance should indicate "local weight," then the standard weights hung on it should be increased in the proportion that the attraction of gravitation is less at latitude 30° than at latitude 45°, or in the ratio 32 174 — 32 131, or 1/1 0013 If 1.0013 pounds is hung on the scale it will indicate 1 pound, and 1 pound hung on it will indicate 0 9987 pound, the "local weight" of 1 pound of matter at latitude 30° Spring balances, however, are never used for weighing as accurately as 1 3 parts in 1,000, since for such weighing a microscope would be needed to read the deflections "Local weight" is rarely needed in engineering problems, and if it should be needed it is determined not by weighing on a spring balance but by multiplying the weight (quantity of matter) by the ratio of the value of g at the location to 32 174

(*m*) "Force may be thought of, roughly, as anything of the nature of a push or a pull" Why "roughly"? The definition of force as a push or a pull is as precise as language can make it

(*n*) "$F/W = A/g$ is taken as the fundamental equation" This is only one form of the fundamental equation The fundamental fact in dynamics is that if a force F is exerted constantly for a time T upon a body free to move, whose weight is W, giving it a velocity V (starting from rest when $V=0$) at the end of the time T, then the following equation is true (in the foot-pound-second system of units)

$$FT=(W/g)V,$$

or, if $A=V/T$ then $Fg=WA$, from which the equation $F/W=A/g$ is derived, also if $M=W/g$, then $FT=MV$ and $F=MA$

(*o*) "If in the fundamental equation $F/W=A/g$ we substitute the expression for mass, $m=c(W/g)$, where c is the numerical factor depending on the choice of units, we have $cF=mA$ Any system of units which make $c=1$ in this equation is called an absolute system of units."

The value of c in the foot-pound-second system is given as 32.174, and in the dyne-gramme-second system as 1. In the foot-pound system $m=32.174W/g$.

This is out of harmony with the engineering text-books and with engineering literature

generally, which make $M = W/g$ If students are taught in elementary mechanics that $m = 32.174W/g$ and in engineering that $M = W/g$, the resulting confusion will be as great as that caused by the poundal and the gee-pound

(p) "The equation $F = mA$ will give incorrect results if the forces and masses are given in any but absolute units In particular it should never be used in the ordinary problems of engineering"

The reasoning that leads up to this conclusion would also condemn the use of the time-honored formulæ $FT = MV$ and $FS = 1/2MV^2$

The equation $F = MA$ is given in all engineering text-books that deal with problems in dynamics, and it has been used from time immemorial with English units and with perfect accuracy

(q) "On account of the special character of this equation, $F = MA$, *it is unfortunate that* it should be so often taken as the fundamental equation of dynamics, instead of the general equation $F/W = A/g$ from which it is derived"

As commonly used by engineers the equation $F = MA$ has no more a special character than the equations $FT = MV$ and $FS = 1/2MV^2$ It is just as fundamental as $F/W = A/g$, which as well as $F = MA$ may be derived from $FT = MV$ If in the last equation we take $V/T = A$, then $F = MA$, and if $M = W/g$, then $F/W = A/g$

Whether a certain equation should or should not be used in engineering depends, (1) on its logical correctness, (2) upon its usefulness The three equations $F = MA$, $FT = MV$ and $FS = 1/2MV^2$, are all logically correct, equally in the so-called "absolute" (C G S) system, the pound-foot system, and the kilo gram-centimeter system, provided that in the C G S. system the unit of quantity of matter is the gram and the unit of force is the dyne, or 1/981 of the force with which gravity attracts a gram of matter at latitude 45°; that in the pound-foot system $M = W/32\,2$ and that in the kilogram-centimeter system $M = W/981$, W being the weight of the body in pounds (or kilograms) and the definition of weight being the quantity of matter in a body, or the force with which gravity attracts it at latitude 45° As to the usefulness of the equations, this has never heretofore been doubted They have filled the engineer's need for a set of handy formulæ for accelerated motion, and they are easily understood by the student

More than ten years ago a high-school student in despair over his problems in dynamics, on account of the obscurity of his text-book and of the teacher's explanations, appealed to the writer for assistance He was told to forget the formulæ of the text-book, with its poundals and units of mass and to memorize the following $V = \sqrt{2gh}$, $S = 1/2VT$, $FT = MV$, $F = MA$, $FS = 1/2MV^2$ and $M = W/g$, F being force in pounds, M nothing else than $W/g = W/32\,2$, or $W/32\,174$ (if great precision is needed) (no "concept of mass" needed) and W weight in pounds (quantity of matter as weighed on a platform scale) With these equations the student soon solved every problem in the book that referred to bodies uniformly accelerated Many times since the writer has had occasion to give the same advice, and always with the same result

Here is a simple problem in acceleration, with its solution by the engineer's method and by the method of the committee's report

What is the draw-bar pull required to accelerate a railroad car whose weight is 100,000 pounds, on a level track, in latitude 30°, at the rate of 1 foot per second per second, friction neglected? The engineer's solution $F = MA$, $M = W/g$, $A = (V_1 - V_0) - T$

$F = 100{,}000 - 32\,2 \times 1/1 = 3{,}105\,6$ pounds

The mathematician's solution First look up the value of g for latitude 30°, $= 32\,131$. In latitude 45° $g = 32\,174$ Weight is the force with which gravity attracts a body at a given place The unit of force (pound) is the force with which gravity attracts the standard pound at latitude 45°, where $g = 32\,174$ A weight of 100,000 pounds at latitude 30° is therefore a force of $100{,}000 \times 32.131/32.174$ pounds, $= W$ "The formula $F = MA$ should never be used in the ordinary problems of en-

gineering" Using the formula $F/W = A/g$ we have $F = AW/g$. Since g is to be taken for latitude 30° its value is 32.131. We then have $F = 1/1 \times 100{,}000 \times 32.131/32.174 \times 1/32.131 = 3{,}108.1$ pounds.

If the engineer had used the more precise value of g at latitude 45° he would have obtained the same result as the mathematician. He would not consider that the value of g at latitude 30° entered into the problem at all. In the mathematician's solution it enters twice, in numerator and denominator, and therefore cancels out.

The only cases in which the engineer ever needs to consider the value of g at latitudes other than 45° are those of precise calculations in which the force of gravity at a particular place enters into the problem, as in the case of the velocity of falling bodies, the power of falling water, the value of the mechanical equivalent of heat, etc. Thus the mechanical equivalent of heat is 777.52 foot pounds, or the work of lifting 1 pound 777.52 feet high, at latitude 45°. The figure obtained by experiments made in raising weights at a lower latitude would be greater in the proportion that the attraction of gravity is less. Steam at a temperature of 327.8° F. has a pressure of 100 pounds per square inch above vacuum if the pressure is measured by its lifting a weight (piece of metal) at latitude 45°. It would raise a heavier weight, in the ratio 32.174/32.131, at latitude 30°, and a lever safety valve would have to be loaded with a larger weight at latitude 30° than at latitude 45° to resist the pressure. A bar of metal tested on a lever testing machine at latitude 45° and showing an ultimate resistance of 32,131 pounds would show 32,174 pounds if tested at latitude 30°, since at latitude 30° the poise on the lever would be attracted less by gravity than at latitude 45°, and it would have to be moved farther out on the scale beam to balance the ultimate load applied to the test piece.

Note on "The Concept of Mass" (Galley 35)

It is not clear just what the report means by the word "mass." It is defined in one paragraph as "the ratio W/g, or a quantity proportional to this ratio, $m = c(W/g)$, W here being a force and not a quantity of matter," but a little later appears the expression "the mass of the body measured in units of mass," indicating that by mass is meant quantity of matter.

A great deal of mental energy has been wasted by teachers and text-book writers in trying to give high school and college students a "concept of mass," and more trouble is yet in store for teachers and students if future text-books adopt the language of this report concerning the "concept."

A boy before he goes to the high school has a perfectly clear idea of matter and of weight. He knows that matter is weighed by the grocer on even-arm balances and platform scales, and he has seen meat weighed on spring balances. He knows that in order to answer the question "How much sugar is in that package?" the weight of the package is obtained by weighing it with a balance, using pieces of metal called weights, or by putting it on a spring balance and noting the indication. He knows that the weight of a pound of lead is 1 pound, whether it is weighed in London or in Panama, and that it is bought and sold as a pound everywhere that English weights are used. He has never heard the word "mass" except in its common meaning, of something like "bulk," or as a general term of indefinite quantity, as in the expression in the preface of the report, "lost sight of in a mass of details." When he begins to study physics, however, he has to learn that what he thinks he knows about weight is all wrong, that the weight of a thing is not constant, but variable, varying with the latitude and elevation above sea level, that it is not the measure of quantity of matter, but only of the force with which the earth's gravity attracts matter, that the word "mass" should be used where he formerly used "weight", and that he must get a "concept" of mass different from the concept of weight. Later he learns that mass is also $c(W/g)$, the ratio of the force with which gravity attracts matter at a given place to the acceleration due to gravity at that place, multiplied by a coefficient, c, which has

different values according to which system of units is used, there being six systems, kilogram-centimeter, pound-foot, dyne-centimeter, poundal-foot, G_s-kilogram-centimeter and g_s-pound-foot, that in the first system the value of c is 980.665, in the second, 32.174, and in the other four systems 1, but that the last three are only in the text-books (and students must study them and pass examinations on them) and are never used in practise. He is also told that the engineer has a different unit of mass from the physicist, 32.2 pounds, which is not true.

When the student gets into practical engineering studies he is told to forget all he learned about the "concept of mass" and that he need think of the word "mass" only as a short term to use instead of the ratio W/g, $= M$, without any coefficient, c, that weight, W, has the same meaning that it has in commerce, quantity of matter, and that g in that ratio is always the constant, 32.2 or, to be more precise, 32.174. What then is the use of confusing the young student with so many notions of the "concept of mass" when he has to unlearn them later?

The Definitions that should be in the Text-books

Criticisms of the definitions of mechanical units given in the report of the committee will fail of their proper effect unless other definitions are offered which the committee may possibly consider when the report is revised for final publication. The following definitions are offered for such consideration as they may deserve.

Weight, W. (1) Quantity of matter in a body, as weighed anywhere on an even balance scale with standard weights. (2) The force with which the earth's gravitation attracts a body at the sea level in latitude 45° (or at any place where the acceleration due to gravity is 32.174 feet per second per second).

Unit of Weight. The pound, the quantity of matter in the standard piece of metal preserved in the bureau of standards in London.

Force. That which causes or tends to cause or to change motion. A push or a pull.

The Unit of Force. The pound, the attraction of the earth's gravitation on a pound of matter at the sea level at latitude 45°.

The weight of a body, W, is both the number of pounds of matter it contains and the number of pounds of force with which it is attracted to the earth at latitude 45°. The two numbers are exactly the same and therefore it is unimportant which definition is used in connection with the solving of problems.

Local weight, W_1, the force with which the earth's gravity attracts a body at any given place, measured in units of force. It may be determined by weighing it accurately on a spring balance which has been graduated at latitude 45°, with standard weights, or, more easily, by computation, multiplying the weight, W, by the ratio of the value of g at the given locality to 32.174. W_1 varies with the location of a body. The difference between the weight of a body and the "local weight" at latitude 30° is (32.174/32.131) — 1, or 0.0013 of a pound, for each pound. The difference, 13 pounds in 10,000, is so small that it need not be taken into account in any ordinary engineering calculation, in fact, the "local weight" is practically never used in engineering problems. When it is needed it is found by computation from the value of g at the given locality.

Mass, M. (1) W/g, the ratio of the quantity of matter in a body (or of the attraction of the earth's gravity upon it at latitude 45°) to the acceleration due to gravity at latitude 45° (32.174 feet per second per second). This is the meaning of the word "mass" when it is used in engineering problems. (2) The quantity of matter in a body, identical with W (1) above, what is called weight ordinarily in commerce and in literature. This is the definition used in many text-books on physics, in which "weight" is restricted to mean what is defined as "local weight" above.

In answer to an objection that may be raised to the double definition of W, (1) and (2), that the same word, in science, ought not to be used to express two ideas that are so dif-

ferent as matter and force, it may be said that the two are in reality one definition. Suppose that a piece of metal, the standard pound, is hung on a spring balance. The position of the pointer on the scale is then marked 1 pound. A second piece of metal is substituted for the first, and if it brings the pointer to the same mark we say its weight is 1 pound. The 1-pound mark indicates two things at the same time, viz., that the quantity of matter in the second piece of metal is 1 pound, and that the force with which it is attracted by gravity is 1 pound. The word weight is thus logically and accurately defined by what may appear to be a double definition. No useful purpose is gained by applying another word "mass" to mean one part of this definition; on the contrary, the use of the word "mass" in this sense is the chief cause of all the confusion to which students are subjected in their study of dynamics.

WILLIAM KENT

SPECIAL ARTICLES

A STRENGTH AND ENDURANCE TEST

SOME time ago one of the newspapers in Kankakee, Ill., arranged a strength and endurance test in which the contestants were to walk 10 miles, each carrying on his back a sack of sand weighing 100 pounds. The course was laid out over the city streets around several blocks, and to complete the test a contestant must cover it 12 times. According to the estimate of the county surveyor, the course was 4,320 feet (1,316.7 meters) in length, and the 12 laps fixed upon for the contest would, therefore, give a total of 9 miles and 4,320 feet (15.8 kilometers), or approximately 9⅘ miles, instead of the estimated 10 miles. The contest required about 4 hours, beginning about two o'clock in the afternoon and closing at dark, which would be about six o'clock on a November day. Prizes were offered to all who completed the test, and special prizes of smaller value to all who completed one or more rounds. The contest was a public affair, and was witnessed by a large gathering of people who lined the streets through which the contestants walked. A stand was arranged for the judges, and in every way provision seems to have been made to insure accuracy as regards entries, distance covered by each contestant, and so on.

Forty-eight men entered the contest. Of these 44 finished the first round, 25 the second round, 22 the third, 19 the fourth, 15 the fifth, 13 the sixth, 11 the seventh, 10 the eighth, 9 the ninth and 8 the tenth, while 6 completed the 12 rounds and fulfilled all the conditions of the contest.

The ages of the six successful contestants ranged from 21 to 52 years, four of them being 36 years old or over. Their body weight ranged from 150 to 255 pounds, the average being 189 pounds (86 kilograms). Of the 38 other contestants who completed one lap the ages ranged from 17 to 61 years, the majority being 30 years or over, while eight were over 40 years old. The body weights ranged from 120 to 200, being on an average 162.4 pounds (74 kilograms).

As shown by the account of the contest published in the Kankakee press, each of the six men who completed the course felt that he was in condition to continue for a longer distance, but this the management did not permit.

The men who entered the contest were residents of Kankakee and were of different nationalities, including Germans, Scandinavians, French Canadians, a Pole and a Turk, while, judging by the published list of names, about one third of them were Americans. The newspaper[1] under whose auspices the contest was held published a list of the winners, with names and addresses, and data regarding their age and weight, as well as a general description of the affair.

Through the courtesy of the editor of the paper, and by correspondence with a number of the contestants, including four of the six who completed the contest, additional data were secured, particularly with reference to the dietary habits of the men and their condition as regards training when they entered the contest. A circular letter of inquiry was sent to the successful contestants and to those

[1] *Kankakee Republican*, 1907, November 29, p. 1.

who completed one lap. Of the replies received four were from the successful contestants, and two from the group completing one lap, while one was unsigned and consequently the group to which the writer belonged is uncertain. It has seemed a fair assumption in discussing the results that he belonged to the larger group, that is, those completing one round and not the entire course. The circular letter made inquiry as to the number of meals eaten per day and as to whether the subject considered himself a medium, hearty or light eater, whether he was fond of athletics and kept in training, and whether his usual occupation involved any considerable amount of physical work. To obtain more specific data regarding the food, one of the questions was "Do you use all the ordinary foodstuffs and beverages such as are given in the following list? If there are any which you do not use, please cross them out." The list included bread, cereal foods, butter, milk, cheese, eggs, meat, vegetables, fruit, sugar, tea and coffee.

The majority of those who answered the questions considered themselves hearty eaters, and all habitually took three meals a day. One considered himself a medium hearty and one a light eater, while one did not specify.

As regards the ordinary foods included in the list, the answers received from the contestants show that, making allowance for some individual preferences, all these men lived on a mixed diet composed of the ordinary food materials, and it is probable that those who replied were fair representatives of the whole number participating in the contest. As regards individual peculiarities of diet, three of those who furnished information stated that they did not use cereal breakfast foods, and one that he used them only sparingly. One of the men ate little fruit except apples, and two used no cheese, while two used neither tea nor coffee and one other no tea.

In the case of the four winners of the contest it seems worth while to summarize in somewhat more detail the data furnished.

F. G., who was 24 years old and weighed 120 pounds (54 kilograms), stated that he was fond of athletics, and while enlisted in the Illinois National Guards had military training once a week. He also stated that he walked to and from work, one and a fourth miles, four times daily, and considered that a good deal of physical labor was required in his daily occupation as a shipping clerk in a retail grocery house, as goods had to be looked over, checked and handled, and the various baskets of goods sent out weighed on an average from 5 to 100 pounds. He used all of the foods mentioned but stated that only a little cereal breakfast food was used and that apples were the fruit commonly eaten.

C. H. O., whose age was 40 years and whose weight was 255 pounds (116 kilograms), stated that he used all the foods mentioned in the list, but that as regards vegetables, turnips and cabbage were only used raw, while onions were not eaten at all. He stated further that he had not engaged in any form of athletics since 18 years of age. He believed that his ordinary work involved considerable muscular labor, but further details were not given.

J. B., who was 52 years of age and who weighed 180 pounds (82 kilograms), stated that he did not engage regularly in any athletic exercises, but believed that considerable muscular work was required by his daily occupation. No further details were given on this point. As regards the character of his food, he stated that he used bread, cereal breakfast foods in limited quantity, butter, milk, cheese very sparingly, eggs, meat (mostly salt pork), vegetables, fruit, sugar, and both tea and coffee in limited quantity. A diet in which salt pork is the principal meat, with eggs, bread, fruit and vegetables would seem to resemble more closely than any of the others the diet which was once very characteristic of farms in many localities, but which is less common now than formerly, owing to a greater abundance of ice for keeping fresh foods and to improved methods of transportation and other modern conveniences. J. B., who was the oldest of the successful contestants, believed that he could have carried the load of 100 pounds for 15 miles.

G. H., the remaining successful candidate who supplied data, stated that he was 21 years

old and weighed 150 pounds (68 kilograms) He was not fond of athletics and did not keep in training, though he believed that his usual occupation involved a considerable amount of physical work As regards food, he stated that he used bread, butter, cheese, eggs, meat, fruit and coffee, and that he did not use cereal foods, milk, vegetables, sugar and tea He considered that he ate a medium amount, as distinguished from the other three successful contestants quoted, who stated that they were "hearty eaters."

Judging from the data summarized, it appears that although there were some individual peculiarities in the selection of food, all four of the successful contestants who supplied data used a mixed diet, made up of the ordinary food materials, and the same was true of the other three men who furnished information.

The question of energy expenditure in walking has been exhaustively studied under a variety of conditions by Zuntz and his associates According to the data obtained by Zuntz and Schumburg[8] with soldiers marching on a level, the energy expenditure for motion of forward progression averages 0 52 calorie per kilogram of body weight per 1,000 meters Practically the same figures for energy expended in walking on a level have been reported by Durig,[9] in his study of respiratory quotient and energy expenditure of men marching on a level, at low and high altitudes

When consulted regarding the probable energy expenditure under the conditions of the Kankakee contest, Professor Zuntz stated that he was of the opinion that a special factor should be used for the load carried, and that not less than 0.6 calorie, perhaps even 0 7 calorie, per kilogram of load per 1,000 meters of distance covered would be a proper factor.

Taking into account the above-mentioned values, the calculated average energy expenditure of the six successful contestants would be 1,137 calories, of which 707 would represent the energy expended in moving 86 kilograms, the average body weight, over a distance of 15 8 kilometers, and 430 calories the energy expended in moving over this distance the load which was carried

As regards the individuals who completed the entire course, the calculated energy expenditure for F G, who weighed 54 kilograms, would be 874 calories, of which 444 calories represents the energy expended in moving the body over the course, and 430 calories that for the load The energy expenditure for O. H O, who weighed 116 kilograms, was calculated to be 1,383 calories, of which 953 calories represents the expenditure for the body, and 430 calories that for the load. For J B, who weighed 82 kilograms, the calculated energy expenditure would be 1,104 calories, 674 calories representing the expenditure for the body and 430 calories that for the load G. H. weighed 68 kilograms, and in his case the energy expended in carrying the load over the full course would be 989 calories, of which 559 calories represents the expenditure for the body, and 430 calories the expenditure for the load

In the case of the 38 other men, with an average weight of 73 8 kilograms, who completed one lap in the contest, the calculated energy expenditure would be 84 calories, of which 49 calories represented the energy expended for forward progression of the body, and 35 calories the energy expenditure involved in carrying the load

Thirteen men completed half the course Assuming that their average body weight was the same as the average for all the men who completed one round, namely, 75 kilograms, the calculated average energy expenditure would be 523 calories, of which 308 calories represents the expenditure for moving the body over the course, and 215 calories represents the energy expenditure for moving the load.

Like most towns in the middle west, the streets of Kankakee are comparatively level However, in the account quoted it is stated that there is a grade of about 9 feet per hun-

[8] "Physiologie des Marsches," Berlin, 1901, p 299

[9] *Denkschriften der Mathematisch Naturwissenschaftlichen Klasse der Kaiserlichen Akademie der Wissenschaften*, 86 (1909), pp. 242–291

dred on one of the streets over which a part of the course was laid. This, if it constituted any large part of the whole, would naturally increase the work performed, but apparently the greater part of the course was over streets with very little grade.

Since accurate data regarding the grade of the entire course are not accessible, it has seemed best to compute the results in detail without trying to take it into account. The organizers of the contest were of the opinion that the grade mentioned made the 10-mile course equivalent, in its demands upon the men, to a level course of 15 miles. If such an assumption be made, it would mean an average energy expenditure of 1,706 calories for those who completed the test.

As a result of the Department of Agriculture experiments with the respiration calorimeter, it has been calculated that a man at ordinary work, such as that of a mason or a carpenter, expends in the performance of his daily work, at least 1,200 calories. This means that the average energy expenditure of the man in performing the work of a contest which lasted four hours was greater than the above value for a day's work.

From a single test and so limited data it would be manifestly unfair to draw sweeping deductions regarding the character of the food in its relation to endurance. It is nevertheless a fact that the four successful candidates who furnished data lived on the ordinary mixed diet of the average citizen, and from all the information collected the same was true of all who entered the contest. This contest is of interest on this account and also because the endurance feat undertaken is comparable with the ordinary forms of muscular work which pertain to usual vocations, and so may be fairly considered as furnishing some indication of the fitness of the subjects for successfully engaging in occupations involving manual labor.

The total number completing the trial of strength is small (6 out of 48) in proportion to the total number of entries, but the number (44) of those who carried the 100-pound weight for nearly one mile is large, while it was not until the men had passed the judges' stand four times that the number of contestants dropped below 20.

It seems fair to conclude that the men who engaged in the contest were, as regards their food, their occupation and their general living conditions, representative of the very large group of our population who are living comfortably and meeting their daily obligations in a creditable manner, who are, in fact, living the average life of the average man, with its varied activities and interests.

In so far as the recorded data throw light on the subject, they indicate that the average man living the average life is capable of meeting body demands of considerable severity—a conclusion which perhaps few would question, but which it is interesting to consider in the light of numerical data.

C. F. LANGWORTHY
U. S. DEPARTMENT OF AGRICULTURE,
OFFICE OF EXPERIMENT STATIONS

THE USE OF ACID SOIL FOR RAISING SEEDLINGS OF THE MAYFLOWER, EPIGAEA REPENS

MAYFLOWER or trailing arbutus (*Epigaea repens*), probably the best beloved of all the wild flowers of the eastern United States, is rarely seen in cultivation. It usually does not survive transplanting. No evidence has yet been found that flowering plants have ever actually been raised from the seed.

The development of a system of cultivating the swamp blueberry (*Vaccinium corymbosum*), by the use of acid soils,[1] suggested that a similar method might succeed with trailing arbutus, because the two plants have the same natural habitat, and because a symbiotic root fungus similar to the beneficial and probably indispensable root fungus of the blueberry was found to occur on trailing arbutus.

Seeds were procured in New Hampshire in July, 1909. They were sown in a mixture of kalmia peat, sand, and sphagnum. They germinated in August. After successive trans-

[1] "Experiments in Blueberry Culture," 1910 (Bulletin 193, Bureau of Plant Industry, Department of Agriculture).

plantings in an acid soil consisting of nine parts kalmia peat, by bulk, and one part clean sand, the plants in August, 1910, began to form their flowering buds. The larger plants then more than filled a five-inch pot. They were left outdoors during the winter, were brought into a cool greenhouse in March, and in a few days were in full flower. The plants were remarkably beautiful. The flowers had the characteristic color and fragrance of wild ones and were of unusual size, the largest corolla having a spread of seven eighths of an inch. The foliage was free from insect and other injuries to an extent seldom seen in wild plants.

Plants kept in a greenhouse all winter flowered only sparingly, but they furnished an opportunity for the observation of the fruit. The fruit of trailing arbutus is described in our standard works as a loculicidal capsule, but this description is incorrect, and must have been based on an erroneous deduction from immature specimens or imperfect remnants. The fully mature fruit is not a dry pod. It is as juicy as a strawberry. Its style of dehiscence is not loculicidal, but is that exactly if not melodiously described as "septicidally or rather marginicidally septifragal." In examples of perfect development the wall of the fruit while still green and herbaceous splits along the cell partitions into five valves, which spread backward into a five-pointed rosette, exposing the white, fleshy, succulent interior with the minute brown seeds dotted over its surface. The fleshy part, which looks like an unripe strawberry and is about a quarter of an inch in diameter, consists of the whole interior of the fruit, axis and dissepiments as well as placentæ. These observations as to the character of the fully developed fruit confirm the original observations made in New Hampshire in late July, 1909, at the very end of the fruiting season.

FREDERICK V. COVILLE

SOCIETIES AND ACADEMIES

THE TORREY BOTANICAL CLUB

THE meeting was held at the American Museum of Natural History. The meeting was called to order at 8.15 P.M., with Dr. E. B. Southwick in the chair. Twenty eight persons were present.

The scientific program consisted of a lecture on "Orchids, Wild and Cultivated," by Mr. Geo. V. Nash. The lecture was illustrated by a large number of beautiful lantern slides. An abstract of the lecture prepared by the speaker follows.

By the general public any odd or strange flower was considered an orchid, and as an illustration of this common error nepenthes and bromeliads were cited. The large division of endogenous plants to which the orchids belong was illustrated with a slide of the lily, this being taken as typical. Especial attention was called to the stamens and pistil which are distinct in this flower. As an illustration of a typical orchid flower a slide of *Cattleya* was shown. The uniting of the stamens and pistil into one organ, known as the column, was pointed out as the distinctive character of the orchid.

Another interesting feature is the diversity of the lip form. The lip is one of the petals. In some forms, such as *Odontoglossum*, it much resembles the other petals. In *Oncidium* it is markedly different in size and color, in *Cattleya* it becomes more modified by the inrolling of the base into a tube which surrounds the column, in *Dendrobium* a still greater modification occurs in the inrolling of the margins of the lip into a saccate organ, and in *Cypripedium* this tendency is greatly magnified, giving us the "slipper."

The stem or leaves of orchids are frequently thickened, thus serving as storage organs for water. The water supply of many orchids, on account of the habitat on trees and rocks, is very uncertain, and these thickened leaves or stems carry the plants safely through periods of drought. When the thickened stems are short, and round or oval, they are known as pseudobulbs.

Some orchids grow in the ground and are known as terrestrial. These are commonly found in temperate regions, where dangers from frost exist. The majority, however, are epiphytic, that is, they grow on trees, and are found in warm temperate and tropical regions. The number of species is between 6,000 and 7,000, of which about 150 are found in the United States. The two great centers of their occurrence are in the new world, in northern South America, northward into Central America, and in the West Indies, in the old world, in India and the Malay region. A series of slides was then exhibited illustrating some of the common wild and cultivated forms.

B. O. DODGE,
Secretary

SCIENCE

FRIDAY, MAY 12, 1911

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THE SECOND INTERNATIONAL CONVENTION OF THE INTERNATIONAL CATALOGUE OF SCIENTIFIC LITERATURE, LONDON, 1910[1]

BEFORE giving an account of the second International Convention of the International Catalogue of Scientific Literature it will be necessary to briefly review the history of the enterprise and outline its organization. Secretary Henry, of the Smithsonian Institution in 1855, suggested and attempted to establish a Catalogue of Scientific Literature through international cooperation, his efforts, however, were not successful and it was not until the beginning of the publication of the Catalogue of Scientific Papers by the Royal Society in 1882 that his idea was even partly carried into effect. This catalogue continued until 1894 when the Royal Society realized that the task was impossible for any one society or indeed for any one nation to undertake. The Royal Society then through the British Foreign Office called the attention of the governments of the world to the great need of a catalogue of current scientific publications, with the result that an international conference was held in London in 1896 to which twenty-three governments sent delegates, the United States being represented by Dr. John S. Billings and Professor Simon Newcomb. This conference decided that it was both necessary and desirable to begin the publication of a catalogue of scientific literature. Various committees were appointed to consider the numerous questions involved, and a general plan of organization was outlined. A second con-

[1] Read at the general meeting of the American Philosophical Society, Philadelphia, April 20, 1911.

ference was held in London in 1898, Dr Cyrus Adler, of the Smithsonian Institution representing the United States, and a third conference met in 1900 The various plans formulated at these conferences were definitely agreed to and drafts of schedules of classification, the heart of the whole system, were compiled The organization is briefly this all the principal countries of the world, at present numbering thirty-two, undertake to prepare at their own expense a classified index of the current scientific papers published within their domain and to forward the data to a central bureau in London where it is assembled and published in seventeen annual volumes, one for each of the following named subjects Mathematics, mechanics, physics, chemistry, astronomy, meteorology, mineralogy, geology, physical geography, paleontology, general biology, botany, zoology, human anatomy, anthropology, physiology and bacteriology The cost of maintaining the central bureau and of printing the catalogue is defrayed entirely by funds received from the subscribers to the work The regional bureaus are, as a rule, maintained by direct governmental grants The work began with an index of the literature for the year 1901 Supreme control of the catalogue is vested in a body known as the international convention which met in 1905, in 1910, thereafter to meet every ten years This paper is for the purpose of giving an outline of the proceedings of the second convention held in London July 12 and 13, 1910. The event was looked forward to with much interest as the enterprise would then have passed through its formative period and the reports would show to what extent it had become a success. All of the principal countries of the world sent delegates as follows

Austria, Dr. Josef Donabaum (vice-director of the Imperial Royal Court Library, Vienna), *Belgium,* Mons H La Fontaine (director of the International Office of Bibliography, Brussels) and Mons Paul Otlet (secretary-general of the International Office of Bibliography, Brussels), *Denmark,* Dr Martin Knudsen (Copenhagen), *France,* Dr J Deniker (librarian of the Museum of Natural History, Paris), *Germany,* Professor O Uhlworm (director of the German Regional Bureau), *Holland,* Professor D J Korteweg (University of Amsterdam), *India,* Lt-Col D Prain, F R S (director of the Royal Botanic Gardens, Kew) and Mr L H Burkill, *Italy,* Professor R Nasini (University of Pisa) and Cav. E Mancini (Academy of Sciences, Rome), *Japan,* Professor Joji Sakurai (University of Tokyo), *New South Wales,* Professor A Liversidge, F R S, *Russia,* Mons E Heintz (scientific secretary of the Central Physical Observatory, St Petersburg), *South Australia,* Hon A A Kirkpatrick (agent-general for South Australia), *Sweden,* Dr Aksel Andersson (first librarian of the Royal University Library of Uppsala), *United Kingdom,* Sir Archibald Geikie, president Royal Society, Sir Joseph Larmor, secretary Royal Society, and Professor H E Armstrong, F R S, *United States,* Leonard C Gunnell (United States Regional Bureau, Smithsonian Institution)

Mr A B Kempe, treasurer of the Royal Society and Dr P Chalmers Mitchell, member of the Executive Committee, were invited to take part in the convention as was also Dr H Forster Morley, who has since the beginning of the enterprise acted as director of the London Central Bureau.

At the opening meeting held in the rooms of the Royal Society on July 12, Sir Archibald Geikie, president of the Royal Society, was elected chairman and Professor Henry E. Armstrong, fellow of the Royal Society, vice-chairman. Professor

Armstrong is the Nestor of the enterprise and from the beginning of the work has been one of the members of the International Council and chairman of the executive committee Secretaries for the official languages of the catalogue—French, German, Italian and English—were then appointed After an address of welcome by Sir Archibald Geikie and the announcement of a number of hospitable invitations to the delegates, the report of the executive committee was laid before the convention This report formed the basis of most of the discussions that followed and to save repetition its contents will be referred to or quoted in full while reporting the proceedings of the convention

The report stated that the seven annual issues already published had cost the central bureau $257,980, for which $246,410 had been received The size of the first four annual issues had averaged 8,441 pages each, the fifth and sixth issues averaged 10,417 each, the seventh issue contained 9,219 pages The enlargement of the fifth and sixth issues was due to the fact that the various bureaus owing to improved methods had begun indexing journals not previously included in the work When the International Council met in June, 1909, it was decided to use modified titles in the subject index with the result that the seventh issue showed a marked decrease in size and it was estimated that the eighth issue would show an even greater reduction In 1900 it was estimated that the gross income would be $27,500 which it was thought would cover the cost of an edition of 500 copies if each issue comprised not more than 160,000 entries The annual income has been $35,000 while the cost has been $36,855 The increased cost was due to the increased size of the catalogue and also to the fact that a thousand copies instead of five hundred had been printed The working capital needed was larger than originally estimated amounting to a total of $37,500 advanced by the Royal Society on all of which interest is paid It was stated that if the steps already taken were continued the deficit could probably be cancelled, and if the first ten issues could thus be published without loss that in consideration of the extent and difficulty of the enterprise the result would be most satisfactory Foundations having thus been laid for an international organization of great importance and influence it was thought essential that steps be taken to make the existence of the organization better known and its powers of usefulness more fully appreciated

A general discussion of methods looking to reduction of expense then followed taking up among other questions the comparative cost of printing in England and other countries This led to a discussion of the finances of the whole enterprise and the result of the debate may be summed up as follows

That it was necessary to reduce the size of the printed volumes without limiting their usefulness which might be accomplished by revising somewhat the classification schedules so as to reduce the number of cross references and also by abbreviating the references in the subject catalogue Emphasis was laid upon the desirability of consolidating the International Catalogue with other bodies engaged in the preparation of bibliographies of scientific works, thus following a precedent established in 1905 when the Zoological Society of London agreed to cooperate with the International Catalogue in the preparation and publication of the *Zoological Record*. Dr Chalmers Mitchell, secretary of the Zoological Society, on being asked by Sir Archibald Geikie what the saving of expense had been by this fusion of in-

terests replied that the *Zoological Record* when published by the Zoological Society did not pay at all, for it had been prepared by a few zealous specialists who were content with a very small remuneration and the Zoological Society had been willing to bear the expense When the two works were combined in 1905 the Zoological Society did not attempt to reduce the total cost of the *Record* but in fact increased the rate of pay to the compilers He stated that for many reasons it was quite necessary that the fusion should take place, that the combined volume was very much better than the separate publications had been, and that it would have been impossible to keep the *Record* going but for the fusion that had taken place The advantage of amalgamation lay rather in the concentration of effort than in financial saving Sir Archibald Geikie asked if there had been any real difficulties in the combined arrangement, thinking that the fusion was an example of what might be done with other societies As Professor Armstrong and Dr Chalmers Mitchell had been the means of bringing about the consolidation, Dr Chalmers Mitchell's answer is significant He said.

The fusion has taken place, and Professor Armstrong I think will corroborate me in this, we who know the immense difficulties at every stage, know quite well that if the *Zoological Record* could be fused with the International Catalogue Record, then it must be a very easy task to fuse any two other records

The following resolution was then discussed and agreed to

Resolved, That in view of the success already achieved by the International Catalogue of Scientific Literature and the great importance of the objects promoted by it, it is imperative to continue the publication of the Catalogue at least during the period 1911–15 and on recommendation of the International Council during the subsequent five years 1916–20

Following this it was

Resolved, That in view of the resolution arrived at to continue the Catalogue for a further period of five years the Royal Society of London be requested to act as in the past as the publishing body and to make the necessary contracts

Dr Forster Morley was reappointed director of the catalogue and the international convention was authorized to spend annually the sum of $10,000, in addition to the director's salary, for the purpose of carrying on the work of the central bureau

It was then unanimously voted "that it is most desirable that a capital fund should be obtained for the catalogue " It is now apparent that the lack of a capital fund has been the stumbling-block of the undertaking from the beginning Not only has it been necessary to borrow money on which interest must be paid but lack of sufficient income has rendered it impossible to carry out several plans looking to the general improvement of the work Had a capital fund been established in the beginning of the enterprise it would not have been necessary for the subscription price to have been placed at such a high figure, consequently, a larger subscription list could have been expected and a larger edition published at a lower rate to each subscriber No commercial enterprise can exist without sufficient capital and the publication of a great work such as the International Catalogue should not be considered in any other light than as a business enterprise if it is to be regularly continued The subscription cost is $85 per year and experience has shown that if the list could be doubled the cost could be cut almost in half, and if the number of subscribers could be quadrupled a still further reduction in price would be possible A relatively small endowment yielding an annual income of not more than ten thousand dollars to be placed at the disposal of the cen-

tral bureau would render it possible to make many improvements and also to broaden the scope of the catalogue. The sum needed is so small in comparison with the good that could be accomplished that it would be strange indeed if in these days of large endowments some individual can not be found willing to provide the necessary funds. As the idea of the International Catalogue originated in the United States the writer is encouraged to hope that some American will further add to the credit already given to this country by endowing the now organized body with a sufficient fund to properly carry on and extend the work.

At the session of the convention on July 13 methods of administration likely to come before the International Council and the executive committee before the next meeting of the International Convention in 1920 were discussed. Professor Armstrong emphasized the great need of confining the catalogue to references to original contributions to scientific knowledge and of the desirability of constantly consulting specialists in the several sciences regarding the proper classification of the papers indexed. It was thought that the organization could now claim some measure of authority in dealing with questions connected with the bibliography of science and thus bring about greater uniformity in practise. On account of the almost insurmountable difficulties in dealing with the present vast number of journals included in the work of the catalogue it was agreed that a revised list of journals should be prepared to contain only those of recognized scientific importance and that the regional bureaus should agree to index all scientific papers published in these journals early in the year following their publication. The International Catalogue could thus within the year following the appearance of a paper publish a full index of its contents. After much discussion this subject was embodied in the following resolution which was unanimously adopted:

> *Resolved*, That each regional bureau be requested to prepare a list of journals in each science which the Catalogue will completely index in the annual issue following the year of publication and that the central bureau be authorized to publish the lists thus prepared.

The publication of this list does not mean that no other journals are to be considered but the list will consist essentially of journals devoted almost exclusively to scientific matters and these journals will therefore be given precedence in the work of the regional bureaus.

To make it possible to carry out this plan to promptly publish future volumes of the catalogue the following resolution was adopted:

> That the resolution of the year 1900 authorizing the central bureau to close these volumes at different stated dates, each volume to correspond to the literature of a period of twelve months, be confirmed.

The effect of this resolution will be that the separate volumes of the catalogue will not necessarily cover a whole calendar year but will cover a period of twelve months.

Reference was made in the report of the executive committee to a proposed international scheme for the publication of yearly tables of physical-chemical constants and in this connection a communication from Sir William Ramsay was read written in consequence of a resolution passed at the International Association of Academies in Rome to whom an application for patronage had been sent. In the report of the executive committee it was pointed out that this work had been embraced in the original plan for the catalogue and though it was one of great difficulty it was still the intention to publish such tables in connec-

tion with the International Catalogue. It was thereupon voted:

That it be referred to the executive committee, after consultation with the regional bureaus, to consider and decide as to what steps, if any, can be taken for cooperation with the proposed International Commission for the publication of annual Physical Chemical Tables.

The two following resolutions were then agreed to and as each was presented a general discussion of its merits followed. The final decision of the matter can not be better expressed than by quoting the resolutions in full.

The first was,

Resolved, That a committee be appointed to revise the schedules and to make such other alterations as may be necessary in the form of issue of the Catalogue. That it be an instruction to the committee that, so far as possible, the subject index be confined to abbreviated titles and authors' names and numbers to serve as references to the author index. That it be an instruction to the regional bureaus to have in mind constantly the need of maintaining the Catalogue of minimum bulk. That the committee consist of the executive committee and Dr. Deniker, Dr. Heintz and Professor Korteweg.

The executive committee being Professor H. E. Armstrong, Dr. Horace T. Brown, Professor A. Famintzin, Leonard C. Gunnell, Professor H. McLeod, Dr. P. Chalmers Mitchell, Professor R. Nasini, Professor H. Poincaré, Professor O. Uhlworm.

The second resolution was,

That in view of the resolution adopted unanimously by the representatives of the various countries constituting the convention, desiring the Royal Society to continue its responsibility for the publication of the International Catalogue for a further period, the committee appointed be instructed: (1) To take all possible steps to prevent reduplication by the publication of several annual and similar catalogues and indexes on the same subject, by making arrangements such as those now in force with the Zoological Society of London. (2) To obtain further assistance and cooperation in the preparation of the material of the Catalogue from the principal scientific societies and academies and the organizations which collect materials for indexing scientific literature.

The question of the publication of a decennial index referred to in the report of the executive committee was discussed and it was decided that on account of the financial difficulties involved unless the sales of the catalogue increased to a considerable extent the publication of the decennial index could not for the present be entertained. The matter was left for the action of the next meeting of the International Council which would be held within the next two years.

However short the time allotted for this subject may be an account would be incomplete without some mention of the numerous and gracious hospitalities extended to the foreign delegates by the Royal Society, the Royal Society Club and individually by the English members of the convention who lost no opportunity to show their guests every possible courtesy and consideration.

LEONARD C. GUNNELL
SMITHSONIAN INSTITUTION,
April 13, 1911

SOME PRUSSIAN EDUCATIONAL DATA

A MINE of statistical information concerning educational conditions in Prussia is Kunze's "Kalendar fur das hohere Schulwesen Preussens" (Trewendt und Granier, Breslau), which has been issued annually for seventeen years. The 1910 edition has just made its appearance, and the German press is busy rearranging its data and forming conclusions. The interest which Americans in general show in German education warrants some discussion of its information with regard to Prussian secondary schools.

The steady growth in the population of the country is of course accompanied by an increase in the number of secondary schools. In 1900 there were in Prussia, in all, 564

Gymnasien (classical schools) and *Realschulen* (schools with French and English instead of the ancient languages), there are now 725. The city institutions have multiplied more rapidly than those supported by the state. There are now 474 city higher schools as against 251 state schools. In 1900 the figures were 344 and 220. The schools are not increasing in number as rapidly as a few years ago. In 1907, 26 new ones were established, in 1908, 22, in 1909, 12, in 1910, 14.

The practical trend of opinion which instituted the *Realschulen* is still making itself felt. In 1900 there were still 341 *Gymnasien* as against 223 *Realschulen*. Now there are 364 of the former and 301 of the latter. The extreme *Realschule*, however, which offers no Latin at all, is not gaining ground as rapidly as the compromise schools. In 1900 there were 85 *Realgymnasien*, with 138 *Realschulen* and *Oberrealschulen*. Now there are 161 of the former to match 200 of the latter. Here is a faint evidence of reaction against the ultra-practical educational theories of the century's beginning. The *Reformgymnasien*, which begin with a modern language—in all but two cases with French,—in *Sexta* (the lowest of the nine classes) and with Latin in *Untertertia* (the fourth class from the beginning), are increasing in popularity. There are now 110 of them. The *Reformrealgymnasium* in Geestemunde and the one in Osnabruck begin with English instead of French. The regulation *Realschule* offers nine years of French and six of English. There seems no reason for this arrangement except the inertia of French influence. It might be contended that the cultural importance of French warrants great attention to it in the old-line schools but one would scarcely expect such a reason to have much weight with the ultra-practical *Realschulen*.

The line between *Gymnasium* and *Realschule* is not always one of absolute separation. There are numerous *Doppelanstalten*, in which a *Gymnasium* is joined to a *Realgymnasium* or a *Realschule*, and several in which a *Realgymnasium* and a *Realschule* are combined. Some of the regular *Gymnasien* allow students who do not wish to study Greek to substitute a modern language, and there are some instances where *Realgymnasien* and *Realschulen* offer Greek as an elective.

The German secondary schools have never been excessively large. In 1900 there were 60 which had more than 500 students each, in 1910 there are 136. In the former year the Royal Pauline *Gymnasium* in Munster-in-Westphalen and the Guerickeschule in Magdeburg (which was then a *Realschule* and *Realgymnasium* combined), counted 840 scholars each and headed the list. The Guerickeschule lost its *Realgymnasium* and its numerically commanding position, and the school in Munster ceased to grow. The largest Prussian institution is now the city *Gymnasium* and *Realschule* in Mulheim, with 948 boys. If we add the 157 children in the *Vorschule* or preparatory school, who recite in the same building and are under the control of the same director, the school numbers 1,100. The Mulheim school has an average of 31.6 students in a class, its present rival in size, the Royal Berger-Oberrealschule in Posen, with 896 students, has 44.8 in a class.

In 1900 these schools employed 6,860 teachers. In 1910 there are 10,150. The number of officially qualified candidates for these positions decreased considerably during the last decade. In 1895 the number on the waiting list had reached its maximum—1,472. In 1900 it had fallen to 693, and in 1906 to 124. In 1897 there were only 73 unfilled positions in the system. By 1900 the number had increased to 127, and seven years later high-water mark was reached, with 884 vacant places. In the last few years qualified candidates have grown more numerous again. There are now 384, as against 124 in 1906.

Prussian secondary school teachers are generally required to teach two or more subjects. It is interesting to note the equipment of the candidates. One hundred twenty-three are prepared to teach religion and Hebrew, 522 for Latin and Greek, 475 for French and English, 482 for mathematics and physics, 155 for chemistry and natural science, 554 for history and geography, 448 for German, 243 for ath-

letics. Last year's list stood, for the same subjects in the same order, 128, 391, 441, 452, 139, 406, 364, 195. History thus shows the greatest advance, and it is a little surprising to find Latin and Greek coming next. Least popular is religion, and there may be a connection between this fact and the wide-spread criticism of the status of religious instruction in the German schools.

New openings in these schools are not appearing as rapidly as was the case a few years ago. For the last four years the numbers are 355, 323, 286 and 222. Thus the new positions created in 1910 were 133 fewer than in 1907.

The higher schools for girls are, as was to be expected, growing much more rapidly, even though the feminist movement has not taken hold of Germany as vigorously as it has seized some other countries. In 1900 Prussia and her cities were maintaining 104 girls' secondary schools. Last year the number had reached 188, and it is now 225. It will be seen that the rapid increase in the number of these schools is a very recent affair. Twelve of the girls' schools are in charge of lady directors.

There are fifteen regular German secondary schools in other countries, located in Antwerp, Barcelona, Brussels, Belgrano near Buenos-Ayres, Buenos-Ayres itself, Bukharest, Cairo, Constantinople, Genoa, Madrid, Milan, Mexico, Rio de Janeiro, Rome and Tsingtau. Twenty-nine directors and instructors with regular positions in Prussia are at work for the year as exchange teachers or lecturers in other countries.

ROY TEMPLE HOUSE

EDWIN E. HOWELL

ON Easter Sunday Edwin Eugene Howell died at his home in Washington. Geologists, physiographers and educators of our country thereby lost an efficient and appreciated ally.

In the year 1861 the late Henry A. Ward, then professor of geology in the University of Rochester, erected on the college campus a building which he called Cosmos Hall and which was devoted to the assemblage and preparation of scientific material for museums of natural history. The establishment thus instituted grew and developed, and it still flourishes. Its work was performed largely by young men of congenial tastes, who there acquired the practical experience which commended them later to the trustees of larger responsibilities. It thus served incidentally as a training school in the natural sciences and especially in certain branches connected with museums. Among its graduates are Frederic A. Lucas, curator in chief of the Brooklyn Institute Museums, William T. Hornaday, director of the New York Zoological Park, F. C. Baker, curator of the Chicago Academy of Sciences, William M. Wheeler, professor of economic entomology at Harvard University, and Henry L. Ward, director of the Milwaukee Public Museum, and in addition to these the writer, who ranks himself somewhat proudly as senior alumnus. This was Howell's school, his real school despite the fact that the biographies mention only the country schools of his native county and the University of Rochester, which recognized certain special studies by making him a master of arts. He entered it in 1865, at the age of 21, and took his diploma—so to speak—in 1872.

For two years he was a geologist of the Wheeler Survey and then for a year held a similar position in the Powell Survey, his work consisting of geologic reconnaissance in Utah, Nevada, Arizona and New Mexico. Then, having become satisfied that this occupation was not the one for which he was best fitted, he resigned his position and returned to the Rochester Museum, becoming a partner where he had before been an assistant. A few years later he removed to Washington, where he established "The Microcosm," an institution somewhat similar to Ward's Cosmos Hall but devoted more particularly to geologic material and subjects. The modeling of relief maps, in which work he was a pioneer—if not *the* pioneer—for the United States, soon became a specialty, and his monument, for a generation at least, will consist in the plastic representations of physiography, topography and geologic structure which adorn the halls

and walls of museums and schoolrooms throughout the continent

He was one of the founders of the Geological Society of America and was connected with a number of other scientific associations, national and local, but he rarely contributed to their discussions Besides the report on his geologic field work, his contributions to scientific literature included only brief descriptions of meteorites

Personally Howell was quiet, unassuming and sincere His recognized integrity was an important factor in his business success If he had enemies or detractors I have not met them His modeling was not distinguished by its artistic quality, but was realistic whenever the material from which he worked was full His clients found him ever clamorous for facts and anxious to revise work at any stage if it could thus be made more truthful, and his clients, who were numerous among the investigators and teachers of geology and geography, were also his friends

He was born March 12, 1845, in Genesee County, N. Y, and passed his boyhood on a farm In 1880 he married Annie H Williams, an artist His wife died in 1893, but a son and daughter survive him

G K GILBERT

HERMAN KNAPP

THE scant space given in the press to the death of Dr Herman Knapp is but another proof that we have not come to place that value upon great scientists which is characteristic of older countries Had he lived in Berlin or Paris the passing of Dr Knapp would have been one of the great topics of the day, for his was a life of singular usefulness to the community, as well as to the science of ophthalmology, and there were few American medical men who rejoiced in wider renown on the other side of the water than did he He studied at no less than seven European universities He established a dispensary and hospital for eye diseases which is now a part of the University of Heidelberg, at which he taught for four years Settling in this city in 1868, he became at once the foremost practitioner in ophthalmic and aural diseases and the founder of the Ophthalmic and Aural Institute, besides being a professor in the College of Physicians and Surgeons But this is the briefest outline of an enormously busy and useful life Never was there a doctor in New York who gave more generously of his services to the poor and the needy, to them he would go even late at night after an exhausting day's labor, if no other time was available More than that, the whole science of medicine is in his debt for the Archives of Ophthalmology and Otology which he founded, as well as for numerous treatises and text-books of permanent value and for his lasting contributions to the treatment of eye diseases —N Y *Evening Post*

SCIENTIFIC NOTES AND NEWS

DR FREDERIC A LUCAS, curator in chief of the Museum of the Brooklyn Institute, and formerly curator of the U S National Museum, has been elected director of the American Museum of Natural History

DR LEWIS BOSS, director of the Dudley Observatory, Albany, has been elected a corresponding member of the St Petersburg Academy of Sciences

PROFESSOR EDWARD L MARK, director of the Harvard Zoological Laboratory, has been elected a foreign member of the Bohemian Academy of Sciences

DR E B WILSON has been designated Da Costa professor of zoology in Columbia University, succeeding in this chair Professor Henry F Osborn, who becomes research professor of zoology

THE Edward Kempton Adams research fellowship has been awarded by Columbia University to Dr R W Wood, professor of experimental physics at the Johns Hopkins University

A PORTRAIT of Professor John Cleland, who from 1877 to 1909 occupied the chair of anatomy at Glasgow, was presented to the university on April 26 and a copy to Mrs Cleland Before the presentations the senate met and conferred on Professor Cleland the honorary degree of LL D

Dr. Alfred Tozzer, of Harvard University, has been made a corresponding member of the Société des Américanistes de Paris.

President Taft has designated Secretary of Commerce and Labor Nagel and Mr. Chandler P. Anderson, counsellor of the State Department, to confer with representatives of Great Britain, Japan and Russia and to negotiate a treaty for the protection of seals and other mammals in the North Pacific Ocean.

Dr. Issa Tanimura, an honorary fellow in the College of Agriculture of Cornell University, has been appointed by the government of Japan a special commissioner of agriculture to investigate the live-stock industry in this country.

Mr. C. H. T. Townsend has accepted an extension of contract from the Peruvian government, as entomologist of state, to December 31, 1912, and expects to conduct extended parasite work against cotton insects, especially the white scale and the square weevil. A laboratory will be established at Piura, in northern Peru, for the accommodation of the work, and a corps of assistants will be provided.

Dr. L. J. Cole, professor of experimental breeding at the University of Wisconsin, will leave on May 6 for a summer's work in western Europe. His trip will include an inspection tour of all the experiment stations and agricultural colleges.

Professor C. C. Thomas, of the engineering school of the University of Wisconsin, has been appointed the university's delegate to the one hundredth anniversary of the foundation of the University of Breslau, which will be held from August 1 to 3, 1911.

Leave of absence has been granted by the board of trustees of Worcester Polytechnic Institute to Professor Harold B. Smith for a period of two years. About one year will be spent in travel. The second year will be spent in special resident study at Berlin and Zurich, and in the investigation of as many European educational institutions as possible. This leave of absence follows fifteen consecutive years of active work on the part of Professor Smith as head of the electrical engineering department of the institute.

During the Easter recess Professors Gilbert van Ingen and William J. Sinclair led an expedition of Princeton students to Yorktown, Va., for field work on the Miocene formation at that place.

Professor Svante Arrhenius, delivered three lectures at Harvard University on April 25 and 28 and May 1. The titles were "The Mutual Relations of the Exact Sciences", "The Theory of Electrolytic Dissociation," and "Adsorption." A dinner in his honor was given by members of the scientific departments at Harvard on May 3.

Professor E. F. McCampbell, of the department of bacteriology of the Ohio State University, delivered the annual chapter lecture of the Sigma Xi society of that institution on Wednesday evening, April 26, on the subject, "The Poisonous Secretions of Animals."

Dr. George T. Moore, of Washington University, delivered the Sigma Xi address at the University of Missouri on "Modern Botany, its Development and Application."

Lady Kelvin has made a gift of £500 to the University of Glasgow for a prize in memory of the late Lord Kelvin. The prize, which will be accompanied by a gold medal, will be awarded once in three years to a doctor of science whose dissertation contains evidence of distinguished original experimental work.

The freedom of the City of London has been conferred 178 times since the year 1757, the recipients including four scientific men: Edward Jenner, Sir George Airy, Sir Henry Bessemer and Lord Lister.

Dr. Herman Knapp, professor emeritus of ophthalmology in Columbia University, eminent for his contributions to this subject, died on April 30, in his eightieth year.

Dr. Pehr Olsson-Seffer, born in Finland in 1873, formerly instructor in botany at Stanford University, and recently director of the Tezonapa Botanical Station and botanist of the Mexican government, has been murdered by brigands in the Mexican insurrection.

DR CAMERON PIGGOTTY, professor of chemistry in the University of South, died on April 30, aged fifty-five years

MR HENRY SCHERREN, an English writer on zoological subjects, died on April 25

THE death is announced of M Henri Berge, professor of chemistry at the University of Brussels

THE U S Civil Service Commission announces an examination on June 7, to fill one or more vacancies in the position of botanical translator, at $1,400 or $1,500 per annum, in the Bureau of Plant Industry, Department of Agriculture

THE forty-fourth annual meeting of the Canadian Medical Association will be held at Montreal in the first week of June, immediately after the official opening of the new medical buildings of McGill University

Nature states that an important discovery in regard to the existence of man in early Pleistocene or Pliocene strata has been made by the Marquis of Cerralbo in Spain In the alluvial deposits of the River Jalon, which is an affluent of the Guadalquiver, he has discovered very abundant remains of undoubted *Elephas meridionalis* in contact with well-characterized implements of human workmanship of the proto-Chellean type Photographs of the specimens and of the cuttings in which they occur have been received from the marquis in Paris, and Professor Marcelin Boule left Paris in Easter week in order to examine the site and the specimens It is possible that *E. meridionalis* may have survived in the south of Europe from Pliocene into early Pleistocene times, but the association of implements of human workmanship with this early species of elephant is altogether new

OFFICERS of a number of the leading colleges and universities charged with the business administration, met at Yale University on April 27. The following subjects were proposed for discussion

Methods of increasing graduate financial interest in university endowment

The problem of the investment of trust funds—whether to apply each investment to a specific fund, or to invest the funds collectively

Dormitories—their construction, management and the income to be expected from them

What constitutes adequate fire, liability and casualty insurance?

Budget and appropriation systems

The requirement of bonds from students for the payment of college bills

Infirmary administration and sanitary inspection

Pensions for employees and the general question of "welfare work" for employees

The problem of the dining hall

The establishment of central stations for heat, light and power

Consideration of the Carnegie report on "Academic and Industrial Efficiency"

Cooperative purchasing by universities

Should students who can afford it pay the full cost of tuition voluntarily?—about 40 per cent of the cost of education now being paid by the student

"Functional" administration versus "departmental" administration

"Centralized administrative responsibility" versus "committee government"

THE eighth annual session of the Puget Sound Marine Station at Friday Harbor, in the state of Washington, will begin on Monday, June 26, and continue for six weeks, closing on August 5. The laboratory will be under the general charge of Professor Trevor Kincaid, of the University of Washington, assisted by a council representing the several institutions participating in the organization. The instructors with the courses they offer will be as follows *Ecology*, Trevor Kincaid, University of Washington; *Comparative Embryology*, W J Baumgartner, University of Kansas; *Plankton*, John F Bovard, University of Oregon, *General Zoology*, H B Duncanson, State Normal School, Peru, Nebraska; *Algæ*, Geo. B. Rigg, University of Washington; *Phanerogamic Botany*, A R Sweetser, University of Oregon The work of the station entered upon a new phase during the session of 1910, when a substantially constructed three story laboratory was put into commission, provided with running salt and fresh water, electric light, aquarium tanks, etc An addi-

tional building is now under construction. The equipment has been greatly improved through provision for more thorough deep-water dredging operations. Exceptionally fine opportunities are presented for the collection of class material as well as for systematic and ecological study. Information in regard to the station will be supplied by the director, Trevor Kincaid, University of Washington, Seattle, Wash.

The following resolution with reference to the chestnut blight disease was presented by Professor John W. Harshberger at the general meeting of the American Philosophical Society and unanimously adopted on April 22, 1911:

WHEREAS, there has appeared in the eastern United States a destructive fungous disease of the chestnut tree, known as the chestnut blight, which as a disease in epidemic form threatens to destroy the native chestnut throughout North America, be it

Resolved, that the American Philosophical Society in general meeting assembled heartily supports appropriate legislation in Pennsylvania, in other states, or by the national government looking to the eradication of the disease by the establishment of a quarantine, or by other more drastic measures of destroying the diseased trees along the outposts of the infected areas, and be it

Resolved, that the members of the national Congress and the members of the several state legislatures are requested to adopt such legislation, as above mentioned, and appropriate sufficiently large sums of money with the view of stamping out the disease before it reaches the main body of chestnut timber in the southern and southwestern deciduous forests of our country, and it is

Resolved, that the members of the American Philosophical Society will support the movement begun in Pennsylvania looking to the eradication of the disease from our too rapidly disappearing forest areas.

THE London correspondent of the *Journal* of the American Medical Association writes that the National League for Physical Education and Improvement has proposed that the London memorial to the late King Edward, whose great interest in sanitary problems is well known, should take the form of a public health museum. In a recent conference of health-promoting institutions, a discussion on the need of coordination disclosed the existence of over eighty such national agencies in London and of a large number of local agencies in London and throughout the country. It was shown that these suffered much both in finance and work from overlapping, from separation of offices and staff and from lack of coordination. The striking success of the tuberculosis exhibition opened in Dublin and then transferred to the Irish Village in the exhibition at London and to other places throughout the country, demonstrated the great interest taken by the public in sanitary questions. It is proposed to erect a popular museum which should accommodate a permanent collection and also furnish duplicate material for the equipment of traveling vans. It should be a model in constant and close relation with provincial museums to which it would probably give birth. It might also become a loan center for the distribution of replicas of its models and diagrams for circulation among schools and institutions. The building should also form a nucleus for the coordination of the various health-promoting institutions, both metropolitan and national. For this purpose, it should include the following: Two or three meeting halls of different sizes, ten or twelve committee rooms, central offices, a library and reading rooms, lecture rooms, workshop and draftsman's room. The cost of maintenance would be met, to some extent, by the rental of suites of offices, halls, committee rooms, especially by health-promoting conferences and institutions, and to some extent by small fees for courses of instruction. In the main, however, instruction must be given at a low cost, fees being charged only when they will guarantee greater interest in those who pay, and being reduced to such a level as will admit of the greatest possible use of the facilities provided. This would be sufficient grounds for appealing for subscriptions to trades unions, friendly societies, insurance companies and the general public. An appeal will be made for a memorial sum of $500,000 and a subscription of $25,000 a

year as a minimum The early cooperation of organizations of the working classes and of those working for the prevention of tuberculosis and alcoholism will be sought

THE Weather Bureau has published for many years the *Monthly Weather Review*, treating of the general weather conditions throughout the United States as a whole, with occasional summaries of climatic data from other and frequently little known regions of the earth Also there have appeared in its pages many scientific and popular contributions from the best students of meteorology and kindred subjects, thus making it one of the leading meteorological and climatological journals of the world A considerable number of the several monthly and annual issues of this publication have accumulated in the files of the Weather Bureau and it is thought they would be a valuable addition to any library If any library desires copies of these publications, either for the completion of broken files or as new matter of public interest, copies of such issues as are available will be furnished free of charge upon request

UNIVERSITY AND EDUCATIONAL NEWS

COLUMBIA UNIVERSITY has received an anonymous gift of $10,000 annually for four years for surgical research, and a gift of $15,000 for five years for the establishment of a bureau to study legislative drafting

FURMAN UNIVERSITY, the Baptist College of South Carolina, has now in course of construction a $50,000 science building which will accommodate the departments of chemistry, biology and physics with lecture rooms and laboratories Half the cost of this building was supplied by local contributors and the other half was the gift of Mr Rockefeller It is expected that the building will be completed and ready for occupancy at the beginning of the next session, in September

MISS A. H. CRUICKSHANK, daughter of a former professor of mathematics in Aberdeen University, who during her lifetime made generous gifts to the university, has bequeathed £22,000 for the endowment of a chair of astronomy, the establishment of a science library and the provision of law prizes in the university, and the residue of her estate for kindred objects

THE Drapers' Company, London, has granted £6,000 to the Battersea Polytechnic for the erection and equipment of a department of hygiene and physiology

DR HENRY PIKE, of the University of Chicago, has been appointed assistant professor of physiology and Dr Warfield T Longcope, of the University of Pennsylvania, assistant professor of medicine in Columbia University

AT Cornell University Mr F K Richtmyer has been promoted to be assistant professor of physics, Mr C W. Bennett, to be instructor in chemistry, and C K Carpenter to be instructor in experimental engineering

THE following promotions have been made in the department of botany of the University of Chicago Charles J Chamberlain, advanced from assistant professor to associate professor, Henry C Cowles, advanced from assistant professor to associate professor, William J G Land, advanced from instructor to assistant professor, William Crocker, advanced from instructor to assistant professor

DISCUSSION AND CORRESPONDENCE

PHARMACOLOGICAL ACTION OF THE NON-ALCOHOLIC CONSTITUENTS OF ALCOHOLIC BEVERAGES

TO THE EDITOR OF SCIENCE In a recent number of SCIENCE[1] D D Whitney, in an article entitled "The Poisonous Effects of Alcoholic Beverages not Proportional to their Alcoholic Contents," cites the following sentences from my report on the pharmacological action of ethyl alcohol[2]

The more concentrated alcoholic liquors or spirits are, from a practical point of view, the

[1] April 14, 1911, p 587

[2] "A Critical Review of the Pharmacological Action of Ethyl Alcohol, with a Statement of the Relative Toxicity of the Constituents of Alcoholic Beverages," by John J Abel, pp 1–169 in Vol II, "Physiological Aspects of the Liquor Problem," Boston and New York, Houghton, Mifflin & Co, 1903

most toxic of all alcoholic beverages If whiskey or cognac were always to be diluted with water until the percentage of alcohol was brought down to ten per cent, they would be no more toxic than wine of the same strength

He then remarks

These statements would lead one to infer that if the alcoholic content of all beverages was reduced to the same percentage, the toxicity of each beverage would be the same If true, such a conclusion would greatly simplify the method of determining the relative harmfulness of the many kinds of alcoholic beverages

It is easy to give a wrong impression by use of sentences removed from their context Statements that precede and follow may be absolutely necessary to convey an author's true meaning Had Whitney included the whole of the paragraph whose beginning he quotes, he could not have drawn an inference which gives an incorrect impression of my report The rest of the paragraph is as follows:

In fact, a number of French authorities maintain that the finest wines are, in proportion to the amount of alcohol contained in them, more toxic than the brandies The question of the relative toxicity of the various constituents of alcoholic beverages has been narrowed down to a study of the action of the higher alcohols, the ethers and aldehydes as compared with that of ethyl alcohol This point of view is justified for the stronger beverages, such as the liqueurs, brandy, rum, whiskey, etc, and the stronger wines As we have seen, however, a study of the misuse of beer would have also to take account of other factors As these factors have not yet been made the subject of special study, we shall confine ourselves to the by-products found in spirits and wines

Numerous other passages could be cited to show that the word "all" has no place in Whitney's inference On page 23 of the report may be read

The liquor sold in France under the name of absinthe contains all the way from forty seven to eighty per cent of ethyl alcohol and is highly flavored with the aromatic constituents of wormwood, anise, fennel, coriander, calamus aromaticus, hyssop, marjoram, etc, the proportion and selection of these flavors varying with the special variety of the absinthe As long ago as 1865 Lancereux maintained that alcohol is, from a quantitative point of view, the chief poison of absinthe Yet there can be no doubt that if the alcohol were removed from absinthe, its excessive consumption would still wreck the nervous system, because of the presence in large amount of the aromatic constituents enumerated

My report had to deal principally with the effect of the various constituents of alcoholic beverages on the higher animals and man, since the work of the Committee of Fifty concerned itself with the problem of intemperance. The experiments of investigators on the action of the higher alcohols, esters, aldehydes and other by-products of alcoholic beverages were given, as also tables showing the relative killing power of these constituents for higher animals and statements in regard to what was known of their action in chronic alcoholism

From all these studies it was concluded that ethyl alcohol is the *preponderatingly harmful ingredient of alcoholic beverages,* and poisonous enough to account for all the evils of intemperance, an ingredient compared with which the small quantities of higher alcohols, aldehydes, etc, associated with it in alcoholic beverages may be neglected by those who seek to reform those evils. Nevertheless the report furnishes abundant proof that the action of the various by-products or non-alcoholic constituents of these beverages were duly considered so far as the data at hand at that time (1899–1900) were applicable to man and the higher animals In the section of the report dealing with the subject of chronic alcoholism passages like the following may be read.

The two examples that have been cited show how necessary it is to study the behavior of *each*[1] of the by-products in alcoholic drinks when administered by itself over a long period before we can attribute to each its own share of the harmfulness which ensues from the prolonged and excessive use of spirits, wines, etc It is not enough to know the toxic equivalent of an alcohol or of a by-product as measured by the experiments detailed in the preceding section in order to deter-

[1] Italics as in the original.

mine precisely what effects will follow their prolonged administration But experiments on animals involving the daily and prolonged administration of small quantities of *each* of the several higher alcohols which are found to exist in traces in distilled liquors are not as numerous as could be desired

Again in speaking of alcohol as a respiratory stimulant, p 116, it is stated that highly flavored wines, brandy and other alcoholic beverages which contain larger amounts of stimulating esters have a more pronounced action than ethyl alcohol and in numerous passages elsewhere throughout the book it will be found that the pharmacological action of ethyl alcohol is contrasted with that of the by-products of alcoholic beverages On p 10 may be read "In 'pure' wines the various ethers and aldehydes constituting the 'bouquet,' the degree of acidity, the amount of sugar and salts, are of importance, both from a medical and from a hygienic point of view"

A report which aims to show that ethyl alcohol is the chief deleterious agent of alcoholic beverages and the one mainly responsible for the evils of intemperance should not be so quoted that one could infer that it was there stated or implied that the effects of *all such beverages on all living things (including rotifers) is to be measured only by their alcoholic content*

JOHN J ABEL

BALTIMORE,
April 19, 1911

THE APPOINTMENT, PROMOTION AND REMOVAL OF OFFICERS OF INSTRUCTION

THE address by President Van Hise, "The Appointment and Tenure of University Professors," which was printed in SCIENCE on February 17, 1911, is interesting in many ways It shows, in the first place, the prevalence of a strong feeling that there is something unsatisfactory about the way in which the power of appointment and removal is exercised in our universities, and, in the second place, it is noticeable for a tacit acceptance of the common assumption that any objection to the way in which a public trust is administered implies a demand for a change in the machinery by which its administration is effected, and does not, as might more naturally be thought, perhaps only exhibit a desire to see the power that directs the machinery made more intelligent If our cities are badly governed by mayors and councils, the remedy is sought in government by commission or in some other purely mechanical attempt to change the locus of power, instead of in the more laborious and less outwardly promising task of purifying it of selfishness and ignorance, and President Van Hise seems to deal with the question of university government from a similar point of view, although, to be sure, he does so for the most part negatively and by inference rather than positively and directly He is undoubtedly right in his contention that the president is the proper officer to be entrusted with the power of appointment and removal, although many will question his implication that the president's right to this power rests on the fact that he makes wise and courageous use of it He is also right in insisting that removals are necessary when efficiency or usefulness are destroyed by physical, mental or moral weakness; and he is justified in attributing some (but not all) of the opposition of faculties to the presidental power of appointment and removal to their selfish desire for permanent sinecures, but his address implies an attitude on some other points to which exception may be taken

For one thing, he is too sanguine, for he assumes two things that there is considerable reason to doubt He seems to think, first, that the acts of governing boards of universities are always in the interests of the students and the public, and, second, that public condemnation is visited swiftly and certainly on all college presidents who employ the power of removal with even a suggestion of unreasonableness or injustice. That these two assumptions are justified may fairly be called into question

One of the greatest weaknesses of American universities, according to an opinion of wide prevalence, is their governing boards These

bodies, composed for the most part of men without anything but the most superficial knowledge of educational practise, often without liberalizing experiences or any real intellectual training, may afford avenues of approach to funds available for the support of educational activities, but they can take no constructive part in educational work, and therefore their action is most intelligent when it is purely perfunctory, as, fortunately, it is for the most part. This is a very general estimate of the worth of governing boards, and there is evidence to bear out its correctness in President Van Hise's address. He says that governing boards merely consider the question of finances in establishing new chairs, so, we may suppose, that if any faculty should so far forget itself as to imagine that a chair of mendacity was necessary, the average governing board would merely count up its cash and determine by that action alone whether to establish it or not. Of course it will be objected that this is a flippant and incomplete way of stating the situation, and that governing boards limit their direct responsibilities to financial matters, leaving all questions of instruction to the sole decision of the faculty. This answer is unconvincing, however, because it is impossible to consider the financial and the intellectual sides of such questions separately, and because it is not fair that the faculty should have only responsibility and no authority in such matters. The fact that there is a strong feeling that governing boards have much power that they do not use intelligently, and that they exercise much authority without being willing to accept a corresponding degree of responsibility, is probably a stronger reason than the one given by President Van Hise for faculty objection to the interference of outside bodies in the matter of teaching appointments. The remedy for this condition, however, does not lie in changing the functions of the officers who interfere or in abolishing them, but in changing their character so that their action on such matters shall be intelligent. If university governing boards were selected with more discrimination than they are at present, and were therefore able to give intelligent consideration to all the larger questions that confront their institutions, many other problems besides those in connection with the appointment and removal of officers of instruction would be solved, and complaints of appointments due to favoritism and expediency or of flagrantly unjust removals could be dismissed as the cry of irritated incompetence—something that can not be done with many that are now made.

It would be pleasant to be able to believe that the public is sure to reprehend any abuse of the power of appointment or removal, but any one who is familiar with the way in which that power has been exercised in many of our universities will have some difficulty in doing so. The public is likely to take an interest in the case of a man whose removal can be attributed to his political or religious opinions, but where only intellectual fitness and teaching efficiency are involved it shows little interest, unless by some accident the case becomes exploited sensationally. It is very much as it is with the exercise of political power. On certain irregular occasions there is great excitement over the appointment of an incompetent or the removal of an efficient public officer, but as a general thing it is taken as a matter of course that such acts shall be unintelligent and inspired by selfishness oftener than a sense of duty. In SCIENCE for August 19, 1910, Professor A. W. Crawford, of Manitoba University, has a letter calling attention to the fact that the University of Pittsburgh, by faculty changes that involved the removal of two professors, effected a saving of $2,000 a year, but that $1,500 of it was added to the salary of the executive officer who made the removals. If the facts are as stated, it would seem that the University of Pittsburgh would be an especially good place to establish a school of politics, as the performance would do credit to some of our most abused municipal governments. The public, however, does not seem to have been at all disturbed by it, in spite of the fact that a reform wave struck Pittsburgh about the time it was done and several councilmen were indicted.

Another illustration of the way the public takes removals can be found in the case of Brown University A dozen years ago the removal of a man from this institution stirred the whole country The man, however, was the president of the university, he had guided it during the period of its greatest development, was, perhaps, its most distinguished living alumnus, and he was removed for holding opinions that were an issue in national politics at the time Ever since that time, according to common report, the power of removal has been invoked in the same institution with great frequency against less conspicuous men Repeated complaints have been raised of men having been cajoled, crowded or thrust out of the Brown faculty with varying degrees of suddenness and consideration In some cases the men so treated had served the university for many years without being found incompetent or even unworthy of regular promotion—something which in most institutions is regarded as establishing a claim that prevents removal on the ground of natural unfitness In other cases, whatever the justification for removal, the action was accomplished in a way to rob it of all appearance of tact and dignified decision, and yet the public has shown no disposition to visit reprehension on the institution, although, according to President Van Hise, it would be sure to do so under circumstances far less capable of being interpreted as indicating unwise or unjust action

The fact that removals are sometimes necessary does not justify the inference, as President Van Hise implies it does, that every removal made is a just and wise one It is because faculties feel that many are both unwise and unjust that there is so much complaint against the power that makes them, and it is the fact that there is some warrant for this feeling, that gives these complaints their force Even if all removals were justified, however, President Van Hise's address shows that executive officers would not be free from all blame in connection with them He states that the college president usually approves without question all nominations for minor appointments, and that only in the case of promotions or appointments to positions of professorial grade does he give the matter any personal attention He might have added, had it lain within the scope of his paper, that many universities exploit their minor appointments in various ways, and by so doing attract many men into teaching who later on have to be removed It must be admitted that some probation is necessary before the fitness or unfitness of a teacher can be determined, and it may be that a college president's time has too many demands on it to permit him to consider every minor appointment It requires, however, something else besides experience to make a teacher, for some mental equipment and training is necessary on which to superimpose that experience, and it lies within the power of college presidents to insist on the possession of this equipment and this training It is also within the power of college presidents to stop the practise of appointing men to minor teaching positions for no better reason than the fact that they will swell the number of graduate students As to whether a president can reasonably be expected to have time to devote to considering minor appointments, it can only be said that if he has not, it might be well to create officers to relieve him of some of his duties and enable him to do so A travelling press agent might serve the purpose Such an officer could relieve the president of the junketing and of the task of conducting the enthusiasm campaigns that are now deemed necessary to keep a university prominent in the race for numbers and notoriety, and the president could be left free to devote himself to more purely intellectual matters It might even be found that the press agent was unnecessary, and that if college presidents devoted themselves more to their natural responsibilities, the gain in efficiency might prove to be a far more effective advertisement than the most ingenious press agent could ever devise or the most energetic one ever carry out

But if it is not possible to agree with Presi-

dent Van Hise that college presidents should be entrusted with the power of appointment and removal because they invariably use it in the interests of efficiency and justice, it is possible to believe so for other reasons. In the first place, if the president makes the appointments responsibility can be brought home to an individual, whereas, if the faculty made them, it would be distributed among a body of men, and individuals could evade it. Then the president ought to be better able to perceive the needs of the whole institution than the faculty, for the views of faculty members are sure to be narrowed by an inevitable tendency to give undue importance to their own and allied subjects. A still more important reason for the president's making the appointments, however, is the fact that he is not like members of the faculty influenced by a fear of competition. It is natural that professors on whom the task of recommending appointments falls should prefer docile mediocrity to men of ability sufficient to develop into rivals for the positions they hold. Intellectual men are proverbially jealous, and the keenness with which they scent rivalry is remarkable, so it is not to be wondered at that promising men find the gateway to teaching closely guarded against their entrance, and that those who succeed in slipping by soon find their path so obstructed that many of them retire in disgust. This is something for the president to correct. His penetration should be sufficient to detect this practise, his courage, decision and dignity sufficient to suppress it and to replace it by a spirit of earnest emulation between teachers of the same as well as different subjects. Unfortunately college presidents do not seem now to be selected because they possess inspiring moral and intellectual qualities, but, one is often tempted to believe, because they can clothe popular fallacies and meaningless commonplaces in language of seeming profundity, or because they are skilful in a sort of emasculated machiavellism. When the public learns to take its responsibilities to education more seriously, we shall have college governing boards and college presidents who discharge their duties more intelligently, and this in turn will ensure faculties of higher effectiveness, so that the whole machinery will acquire a nicety of adjustment that will enable its various parts to work together without the friction that takes place between them now.

It would seem, then, that President Van Hise is right in saying that the present machinery of education needs no external modifications, but it is impossible to accept his implication that educational results are satisfactory. As a matter of fact, present results are very poor, not only in the matter of appointments and removals, but in a general way as well. The only way to improve them, however, is to render the real guiding power of education—public opinion—more intelligent.

SIDNEY GUNN

MASSACHUSETTS INSTITUTE
OF TECHNOLOGY,
March 3, 1911

SCIENTIFIC BOOKS

A NEW TRANSLATION OF ARISTOTLE'S "HISTORY OF ANIMALS"[1]

"THE History of Animals," by Aristotle, much as it is referred to by naturalists as well as others, has never appeared until lately in a fitting English dress. At last a translation has been published from the pen of a scholar who combines, to an eminent degree, the principal qualifications necessary for such an undertaking—an adequate knowledge of the Greek language and acquaintance with the Grecian fauna. D'Arcy Wentworth Thompson, professor of natural history in University College, Dundee, is the man to whom we are indebted for the new work. It "has been compiled at various times and at long intervals during very many years" and was so long delayed that we had almost despaired of see-

[1] The works of Aristotle translated into English under the editorship of J. A. Smith, M.A. [etc.], and W. D. Ross, M.A. [etc.], Vol. IV., Historia Animalium by D'Arcy Wentworth Thompson, Oxford, at the Clarendon Press, 1910. 8vo, pp. xv + 486^a–633^a + 151.—$3.40.

ing it in print, but we are glad at length to welcome its appearance.

I

Besides various abortive attempts and fragmentary translations, two completed English versions of the "History of Animals" had been published, one in 1809 by Thomas Taylor and another in 1862 by Richard Creswell. Both works evince not only an inadequate knowledge of Greek, but an extremely imperfect acquaintance with zoology and consequently would very frequently mislead the reader. The following extracts from the three translations will serve to give an idea of the characteristics of the several versions and might be paralleled to an indefinite extent.

APES, etc.

Taylor, p. 48 (II, viii., ix.)

Some animals however have an ambiguous nature, because they partly imitate man and partly quadrupeds, such as apes, the cœbi [a kind of apes] and the cynocephali. But the cœbus has the tail of an ape, and the cynocephali have the same form with apes, except that they are larger and stronger, and they have a more canine face. Their manners also are more savage, and they have teeth more canine and strong.

Creswell, p. 32 (II, v, 1)

Some animals unite in their nature the characteristics of man and quadrupeds, as apes, monkeys and cynocephali. The monkey is an ape with a tail, cynocephali have the same form as apes, but are larger and stronger, and their faces are more like dogs' faces, they are naturally fierce, and their teeth are more like dogs' teeth, and stronger than in other genera.

Thompson, 502ª, lines 16–22.

Some animals share the properties of man and the quadrupeds, as the ape, the monkey and the baboon. The monkey is a tailed ape. The baboon resembles the ape in form, only that it is bigger and stronger, more like a dog in face, and is more savage in its habits, and its teeth are more dog-like and more powerful.

These are versions of the following Greek original copied from Bekker's edition.

Ἔνια δὲ τῶν ζῴων ἐπαμφοτερίζει τὴν φύσιν τῷ τ' ἀνθρώπῳ καὶ τοῖς τετράποσιν, οἷον πίθηκοι καὶ κῆβοι καὶ κυνοκέφαλοι. Ἔστι δ' ὁ μὲν κῆβος πίθηκος ἔχων οὐράν. Καὶ οἱ κυνοκέφαλοι δὲ τὴν αὐτὴν ἔχουσι μορφὴν τοῖς πιθήκοις, πλὴν μείζονές τ' εἰσὶ καὶ ἰσχυρότεροι καὶ τὰ πρόσωπα ἔχοντες κυνοειδέστερα, ἔτι δ' ἀγριώτερά τε τὰ ἤθη καὶ τοὺς ὀδόντας ἔχουσι κυνοειδεστέρους καὶ ἰσχυροτέρους.

A comparison of the several versions with the original shows that Taylor's is quite unreliable, Creswell's is the most literal, and Thompson's correct, free and the most idiomatic from an English point of view.

Taylor has corrupted the word kebos into cœbus, for which there is no justification, and has reversed what Aristotle said as to kebos, the original author declaring that it is a pithekos with a tail.

Creswell's chief fault, in this paragraph, is the omission of the English equivalent for "cynocephali"—baboons; the last four words are uncalled for.

Thompson's is pervaded with a full knowledge of what Aristotle said. He has preferred to change the number in several cases, giving the singular instead of the plural. His use of the word ape (instead of macaque), in common with his predecessors, may mislead many, inasmuch as ape is now so generally restricted to the large, tailless simiids (chimpanzee, gorilla, etc.) that they are involuntarily brought to the mind, to the exclusion of others, by the word. Nevertheless, Professor Thompson may claim perfect justification in the fact that the word originally included the monkeys and that the macaques are still popularly known as apes, the northernmost and typical species being especially called Barbary ape. Some might also prefer to express Aristotle's meaning by a phrase like "Some animals combine in their shape characteristics of man and quadrupeds."

One more example (descriptive of the Greek catfish glanis) will illustrate other weaknesses of the older translators. Book VIII of the "History" is under consideration.

THE GLANIS

Taylor, 325 (VIII, xx.)

. . . the glanis, in consequence of swimming on the surface of the water, is injured by the deadly influence of the dog star, and is laid asleep by very loud thunder. Sometimes, likewise, the carp is affected in this manner, but in a less degree.

But the glanis perishes when struck in shallow water by the serpent called a dragon

Creswell, p 219 (VIII, xx, 12)

the glanis, from its swimming near the surface, appears to be star struck by the dog star, and it is stupefied by loud thunder The carp suffers in the same way, but not so severely The glanis, in shallow water, is often destroyed by the dragon serpent

Thompson, 602[b], lines 22–26

For instance, the sheat fish just before the rising of the Dog star, owing to its swimming near the surface of the water, is liable to sunstroke, and is paralysed by a loud peal of thunder The carp is subject to the same eventualities, but in a lesser degree The sheat fish is destroyed in great quantities in shallow waters by the serpent called the dragon

Taylor and Creswell both attribute remarkable offensive powers to the dog-star instead of considering the reference to it as an index of season[2] The notice about the dragon serpent gives an undue air of mystery and weirdness[3] A water snake may seize a catfish as well as other fishes, but sometimes with a fatal result (The present writer, on one occasion on the shore of the Potomac River near Washington, found a large water snake (*Natrix sipedon*) dead with a catfish's trunk in its mouth but the head outside and the pectoral spines immovably outstretched, one piercing the snake's skin behind the corner of the mouth and the other outside)

Professor Thompson has chosen to use the name sheat-fish as an equivalent of glanis That name has been in limited use for several centuries as the designation of the *Silurus glanis* of Europe and has given trouble to lexicographers For example, in the "Century Dictionary," it is derived "appar < sheat[2], a shote, + fish"[4] It was given by Willughby, in 1686, as the English synonym of the German Shaid or Schaid Schaidfisch is an equivalent in northern Switzerland (round Lake Constance or Bodensee) for the same species and doubtless sheat-fish has been derived from that name The English form, to a very limited extent (as by Arthur Adams in 1854), has been used in a wider sense Inasmuch, however, as glanis is a well-known specific name and the fish so called by Aristotle is quite a different species from the true sheat-fish, adherence to the practise of his predecessors in retaining glanis would be deemed desirable by many

II

Aristotle has been frequently and recently called "the founder of systematic zoology" A very distinguished anatomist (Richard Owen) even claimed that "the Zootoka of Aristotle included the same outwardly diverse but organically similar beings as constitute the Mammalia of modern naturalists" All such claims are baseless In view of the frequency with which they and the like are repeated, however, explanation of the scope of Aristotle's work is in place

A striking example of Aristotle's failure to understand principles of natural classification, and fundamental characteristics of animal groups, is exemplified by his treatment of the group of Selachians This, as now accepted, is a very natural division to which class rank has been assigned by some of the best modern naturalists, but Aristotle has ranked with them the angler or fishing frog (*Lophius*) which is only a slightly modified acanthopterygian fish, he did this merely because it was a flat flabby fish and he approximated it to the torpedo because that also was flat and flabby The fact that he repeatedly asso-

[2] The dog star has been long used as a denominator of time For example, Linnæus in 1741, in his autobiographical sketch, records that in the dog days he reached Rouen, on his way to Stockholm, which he reached in September

[3] The "dragon" of the History of Animals was apparently nothing more than an ordinary snake to which extraordinary habits were attributed by popular belief

[4] *Sheat*[2] is defined "The Shad Wright [Prov Eng]," *Shote*[1] "same as Shot[2]," the trout or grayling, and *Shote*[2] "a young hog, a pig" and "a thriftless, worthless fellow" In the old editions of the great "Greek English Lexicon" by Liddell, Scott and Drisler, *glanis* is defined "a kind of *Shad*" The glanis belongs to a widely distinct order from the shad and trout and is not at all like them

ciated the angler with the rays precludes the idea that the error originated with an editor or copyist Many other cases of misplacement of animals, on account of superficial similarity, which differ fundamentally, might be cited did our limits permit It need only be repeated that Aristotle was not "the founder of systematic zoology" and had little or no appreciation of what is now so termed

The "History of Animals," indeed, is by no means a treatise on systematic zoology, but rather a work on physiology It generally includes nine "books," but a tenth was formerly recognized which is now universally regarded as spurious In general terms, in the first three the parts and regions of "blooded" or vertebrate animals are considered, in the fourth the "bloodless" or invertebrate animals and the senses generally are noticed, in the fifth and sixth generation and breeding habits are described and, in the seventh, especially those of man, the eighth and ninth books treat "of the psychology of animals," including the feeding and general habits These categories are by no means exact, however, and various miscellaneous information is interjected No data are given for the determination of the animals considered except what may be found in scattered places respecting certain characteristics, and many species are only noticed once. It is assumed that the reader will know the animals by the vernacular names of the time

There is nothing like a system of the animal kingdom and the groups are only such as were and still are recognized by people without special knowledge of natural history The only categories of classification are the *genos* (genus) and the *eidos* which correspond almost exactly with kind and species or variety of English and are equally vague and to some extent interchangeable Indeed, as Thompson notes (490^b), Aristotle sometimes "seems to juggle with the terms εἶδος and γένος" The only group designations are those in general use, agreeing with English popular appellatives Aristotle especially names the most comprehensive "genera" or kinds of "blooded" animals in book I (Thompson 490^b 9 and 10) and of "bloodless" animals in book IV. (523^b 4–13), the former are Ornithes (birds), Ichthyes (fishes) and Ketoi (whalekind), the latter are Malakia (cuttlefishes), Malakostraca (soft-shelled shellfishes), Ostrakoderma (true shellfishes) and Entoma (insects) Thus each of the Aristotelian "great genera" has received popular recognition among the English as well as other peoples Aristotle, it is true, says (Thompson, I, 490^b 9–11) "There is another genus of the hard-shell kind, which is called oyster, another of the soft-shell kind, not as yet designated by a single term," which he later (IV, 523^b 5) designated as malakostraka, it does not necessarily follow, however, that Aristotle coined the word for the group, he doubtless took an already existent adjective and used it as a substantive A few minor kinds or combinations are recognized, as cetaceans (ketoi), selachians (selachia), horse kind (lophuri) and cuttlefishes (malakia), but otherwise the animals "are only named as it were one by one, as we say man, lion, stag, horse, dog, and so on" (I, 490^b 34)

About five centuries later Apuleius, in his singular "Apologia" or "Defence," gave a list of collective designations or aggregates of animals, and Aristotle's group names constituted practically all the natural groups or classes of the fourteen recorded (Works of Apuleius, Bohn ed, p 286) Many centuries were destined to roll away before the list was added to Indeed, not until the eighteenth century did any naturalist give name to a class independent of popular recognition Linnæus was the real founder of systematic zoology It is true that he was to some extent anticipated by Ray in the previous century, but Ray did not give nomenclatural expression to his logical concepts

Inasmuch, then, as the *genos* and *eidos* are the only categories which have received distinctive names, they only should be recognized Professor Thompson has done this, but he has used the word "genus" in the same vague manner as Aristotle That designation, however, has been restricted by modern naturalists to a group of closely related species and often to a single species when that

had no known close relations The use of the word in the vague Aristotelian sense, therefore, will mislead or at least divert attention, and there is no good reason why kind should not be employed Oliver Goldsmith, however poor a naturalist, was a master of English and he used that word much as Aristotle did genos Thompson's method, however, is far preferable to another translator of Aristotle Dr Ogle, in his generally praiseworthy version of "Aristotle on the Parts of Animals" (p 142), explains that "The vague use of the term [genos] makes it impossible to translate it invariably by the same English word I have therefore rendered it variously — genus — order — tribe — class — natural group — kind, etc, as seemed most convenient in each separate case" Such practise does not convey what Aristotle said or meant, but what the translator thought he ought to say. Most readers will want to know what Aristotle's ideas were and not the editor's

Another case of usage of a word in a different sense from that current is exemplified by the term malakia, which Professor Thompson has translated by mollusks Inasmuch as the latter word is universally extended by all naturalists to a great branch of the animal kingdom, of which the malakia form but a small and aberrant fraction, we certainly have some cause to demur, cuttlefishes is an exact English equivalent of malakia We would prefer to use the last name with the English synonym after it within parentheses Perhaps others would prefer cephalopods instead

Undoubtedly many will also wish that Professor Thompson had given the Greek names of species rather than their supposed English equivalents or, rather, in connection with such equivalents He has, indeed, done so often, but only because he was ignorant or uncertain of the intent of a name There are probably few readers who would use Aristotle for information about animals, most persons would want to know what names he used for animals and what he said or thought about them. Besides, the greater part of the English-reading people live outside the British Islands and to them such words as adder, angelfish, ant, blackbird, dogfish, grasshopper, lizard, viper and the like may convey a different meaning from that familiar to a native Englishman

III

If Strabo is to be credited, some of the manuscripts of Aristotle were subjected to extraordinary vicissitudes and only resurrected after more than a century's entombment in dark and damp hiding places If such were the case[5] with the "History of Animals," naturally in very many places the ink must have been blurred or sometimes completely obliterated It is told that one Apellicon of Teos attempted the restoration of copy and that various editors of subsequent but early times tried their hands at improvement of the text Naturally, then, the Aristotle we know must be often different from that which originated from the hand of the great stagirite

Many emendations have been also made or proposed by various later commentators on Aristotle and many new ones have been suggested by Professor Thompson Thompson had earned the right, by virtue of his attainments and research, to make such, but some of his predecessors had not A flagrant case of ill-advised alteration has been furnished in connection with the words *skaros* and *sparos*, the names of two very notable fishes

Certain authors have proposed to substitute the word *skaros* for *sparos* when it occurs in Book II (508^b 17),[6] Horace A Hoffman (1892) was misled by the suggestion and became so confused that he was "inclined to think that the names σάργος σκάρος and σπάρος are used indiscriminately," and even failed to recognize the *scarus*, perhaps the most famous

[5] There is internal as well as other evidence that the History of Animals was published (multiplied) during Aristotle's life-time

[6] In this case and the following references the first number in roman refers to the "book" of Aristotle's "History" (II), the second to the page of the Prussian Academy's edition adopted by Thompson (508^b), and the third to the line of the page (17) There is no other or independent pagination for the version

fish of the ancients. There is really no confusion in Aristotle's book and his characterizations of the several fishes are quite apt For instance, according to Hoffman, Aristotle "says the σπάρος (or σκάρος, if we follow the other reading) has many pyloric appendages," [etc] and that the σκάρος "has its stomach shaped exactly like an intestine, seems to ruminate just as the quadrupeds do," [etc], these characters differentiate the two almost as well as a modern ichthyologist would do

But there is certainly often occasion for emendation of the generally accepted text and one striking example is the nomenclature of certain fishes which are provided with cæca to the intestines, it occurs in book II (p 508^b 17) of Thompson's translation Probably Aristotle's manuscript had become blurred and illegible at this place and a copyist had inserted words that looked like those that were indistinct or were of the same length

According to Thompson's version, "Fishes have them [cæca] high up about [round] the stomach, and sometimes numerous, as in the goby, the galeos, the perch, the scorpæna, the citharus, the red mullet, and the sparus" Now, assuming that Aristotle knew what he was writing about, the present text is very corrupt

The goby (κωβιός) has no cæca whatever and consequently the name must have been substituted for some other κολίας may have been the original word and the species indicated (*Scomber colias*) would to an eminent degree fulfil the requisite (having very numerous cæca) for the place

The galeos—"γαλεός or the dog-fish, a selachian"—as Thompson notes—"has no cæca. Sch suggests γαλῆ (cf Ael xv, 11), mod Gk γαλία, *Lota vulgaris*, the burbot" That fish has many cæca and therefore would "fill the bill," but unfortunately there is no recent evidence (in Apostolides, Hoffman, Carus or any other recent author) that the fish or the name occurs in Greece A species that would well answer is the bonito (the *pald* of Aristotle, *Sarda pelamys* of recent systematists), which is next in relationship to the *kolias* and whose intestines had elsewhere (506^b 14, 15) been especially noticed by Aristotle

The perch of Thompson (in this place) is not the river perch but a serranid (*Serranus scriba*) still known in Greece as the πέρκα, which has many cæca

The *citharus* does not fulfil the requisites of the proposition in question and is out of place: the name doubtless has been interpolated, κάνθαρος may have been the original word

The names *chromis* and *korakinos* have been involved with *skiaina* to some extent Thus in book IV (534^a 9, 10) the "Chromis or Sciæna" is reckoned among "fishes the quickest of hearing," but in book VIII (601^b 31) the two names appear for distinct species which suffer "most in severe winters" because they "have a stone in their head, as the chromis, the basse, the sciæna and the braize" Thompson, in a note (IV, 534^a), declares that the chromis was "*Sciæna aquila* (or some closely allied fish) said to be still called *Chro* in Genoa and Marseilles" The *Coracinus* has been variously identified "According to Cuvier and J Muller," it was, says Thompson, "*Chromis castanea* (It *coracino, corbo*, etc), the allied fish from the Nile (Athen *l c* [viii, 312]) being *C niloticus* *Umbrina cirrhosa* and *Corvina nigra* are known as *corvi*, and are said to spawn in brackish water, but these we identify with σκίαινα or χρόμις." Gunther thought that "the *chromis* of the ancients appears to be some sciænoid fish" Investigation of the voluminous literature respecting the species involved and the fishes themselves has led to the following conclusions

The *Skiaina* was probably primarily the *Sciæna umbra* of Linnæus (*Corvina nigra* of Cuvier), known now in Greece as the *skios*, as well as under other names

The *Chromis* was apparently the *Umbrina cirrhosa*, to some extent at the present day confounded with the former under the name skios, umbrina, ombrella, etc

The korakinos, as Cuvier and J Muller believed, may have been the *Chromis chromis* (*Heliastes chromis* of Günther). "The allied

fish from the Nile," referred to the same genus by Cuvier, has for more than half a century been associated with numerous other African fishes in a distinct family (Cichlids) and its generally accepted name now is *Tilapia nilotica* *Coracinus* was, however, long a popular name for it, and the "Coracin fish" of Josephus ("Wars of the Jews," III, 10, 8) was doubtless the same or one of the closely related species

The genera *Sciæna* and *Umbrina* belong to the family of Sciænids and *Chromis* to that of Pomacentrids

Apropos of the sexual relations of the selachians, Aristotle brought together most of the names of the species he knew After specific notices of the *batos* (ray), the *trygon* (sting ray) and the *rhine* (angelfish), in Thompson's version (V, 540^b 17) we have this enumeration "And among cartilaginous fishes are included, besides those already named, the bos, the lamia, the aetos, the narce or torpedo, the fishing-frog, and all the galeodes or sharks and dogfish"

Professor Thompson thinks that the bos is "probably *Notidanus griseus*" and the lamia "one of the greater sharks, *e g*, *Carcharias glaucus*, or *Carcharodon Rondeletii*" Such can scarcely be the case Aristotle generally instinctively approximated like forms and he especially segregated "all the *galeodes*" (*πάντα τὰ γαλεώδη*) Inasmuch as the *bos* and *lamia* head the list of flat selachians, they were doubtless rays

The *bos* (*bous*) was almost certainly the *Mobula edentula*, otherwise named *Cephaloptera* or *Dicerobatis giorna* It is known by analogous names (vaca, vacchietta) along the coasts of France and Italy, and allusion is thereby made to the horn-like headfins (caropteres) which project forwards and forcibly remind the observer of a cow's horns Devil-fish is the name by which kindred forms are known along the American coasts

The *lamia* may have been intended for overgrown individuals of the *bous* known only through exaggerated reports It was possibly interpolated by a later editor

The *aetos* was undoubtedly the eagle ray, *Myliobatis aquila* The name is generally supposed to refer to the widely spread wing-like pectoral fins, but Professor Thompson has "little doubt that the original name, still preserved in Sicily, was *pisci acula*, or ἀκυλέης" It is the wing-like expansion and use of the pectorals that is the most striking characteristic of the eagle rays, the spines they share in common with the sting rays (Dasybatids) Professor Thompson might support his conjecture, however, by the fact that, in America, the eagle rays are to some extent called sting rays in common with the dasybatids

The φύκης (male) or φυκίς (female) is named by Thompson "the little phycis or black goby" (567^b 1 10) or merely phycis (591^b 16, 607^b 20) The fish is thus identified unhesitatingly with the *Gobius niger*, as was done by Apostolides, who followed Cuvier and Nordmann The early writers, however, so identified the phykis merely because it had become known as a nest-maker and no other nest-maker than the goby was known Nevertheless, it is now certain that the Aristotelian fish was not a goby but a labrine It was declared by Speusippus (in Athenæus) to be like a sea-perch (*Serranus*) which the *phykis* is not, it was associated with labrines by Aristotle (607^b 18), and it is still called phykopsaro in Greece It is also now well known that several of the European labrines construct nests, those labrines are much more conspicuous and more like the serranids than are the gobies The *phykis* was therefore identified with a Crenilabrus by Gerbe as early as 1861 and there can be little if any question that it really was a labrine It was indeed considered by Belon, more than three centuries ago (1580), to be one of the fishes now known as *Crenilabri* As Gerbe's fine article is almost unknown, it may be noted here as published in the *Revue et Magasin de Zoologie* for 1864 (pp 255–258, 273–279, 337–340) The nest of a northern species (*Labrus maculatus*) has also been described by J D Matthews in the Fifth Annual Report of the Fishery Board for Scotland (1886-7, pp 245–247)

Among the migratory fishes (IX, 610^b 6, 7) are mentioned "the sarginus, the gar-fish,"

etc Professor Thompson notes that "while $\beta\epsilon\lambda\acute{o}\nu\eta$ in VI, 12, etc, is certainly the pipefish, *Syngnathus*, here it may be assumed to mean *Belone acus*, the garfish Mod Gk $\beta\epsilon\lambda o\nu\acute{\iota}\delta\iota$, $\sigma\alpha\rho\gamma\acute{\alpha}\nu\nu o\varsigma$, $\sigma\alpha\rho\gamma\acute{\omega}\nu\nu o\varsigma$, It aguglia $\sigma\alpha\rho\gamma\hat{\iota}\nu o\varsigma$ and $\beta\epsilon\lambda\acute{o}\nu\eta$ are probably synonymous, and one or other of them is interpolated" But here, as elsewhere in the "History," the *Belone* is undoubtedly the pipefish The garpike and pipefish are both very elongate and have the preocular region extended and consequently are sufficiently alike superficially to contrast with other fishes Assuming, then, that the *belone* is the pipefish, the juxtaposed *sarginos* (not mentioned elsewhere) might be conjectured to be the garfish, the conjecture is sustained by the fact that the garfish in modern Greece and the archipelago bears the names Sargannos and Sargõnnus (as Professor Thompson records), as well as *Sargannos* and *Zargana,* these names are clearly but slight variants of each other as well as from *Sarginos* and the real similarity is scarcely veiled by the vagaries of orthography

In the index, Professor Thompson distributes the references to *belone* under two categories, (1) the pipefish, 567ᵇ, 571ᵃ, (2) the garfish, 506ᵇ, 543ᵇ, 610ᵇ, 616ᵃ As already indicated, we consider all the passages in question to be referable to the pipefish, and that alone

In book IX, Aristotle notices the halcyon or kingfisher and especially the nest, he conjectures that "it is possibly made of the backbones of the" *belone,* which Professor Thompson translates "garfish" In a note he adds "If we ask why of all fishes the $\beta\epsilon\lambda\acute{o}\nu\eta$ is specified, it may be because the backbone of the garfish has a peculiar green colour" The Grecian kingfisher, as Aristotle says, "is not much larger than the sparrow," and the garfish is a comparatively large animal and difficult to catch, on the other hand, pipefishes are small, readily obtainable in the vegetation near the shore, and the partly desquamated bodies are easily identifiable

The question of the nomenclature of the *belone* and *sarginos* has been fully considered in an article "On the Families of Synentognathous Fishes and their Nomenclature" in the *Proceedings* of the United States National Museum (1895, pp 167–178) To this reference may be made for further details

IV

Here we must bring our already too lengthy review to a close, although many other passages had been marked for comment or praise The review has been mostly confined to one class because representatives of that class have been most misunderstood and many species erroneously identified Professor Thompson's acquaintance with other classes has been greater and he had some years ago published an excellent book on Greek birds

The new "History of Animals" deserves further commendation on account of its dress as well as contents It is printed in excellent form, as would be expected, having come from the Clarendon Press A new feature, so far as English editions are concerned, is the illustration of various passages by apt and clear figures (eleven in number) explanatory of the Greek text which is subjoined There are remarkably few typographical errors Such are inevitable, however, in a work of its magnitude, and among them are the transposition of the figures 1 and 2 in explanation of the illustration of *Squilla mantis* (525ᵇ), 185 instead of 1856 (568ᵃ note), and *mormirus* in place of *mormyrus* (570ᵇ note) There is one other lapsus to which attention may be called because it is so often made by other writers

Professor Thompson has been misled several times by a French custom of individuals or families adding agnomina to their names The distinguished publicist and translator into French of Aristotle's works, Jules Barthélemy Saint-Hilaire, and the great French naturalists, E and I Geoffroy Saint-Hilaire,[7] are all referred to only under their agnomina In conversation and "for short" the agnomen would be generally dropped, Barthélemy only being used for one and Geoffroy for the other Thus Cuvier, once the intimate associate of

[7] The "G St Hilaire" of p 612ᵃ (note) was Étienne Geoffroy Saint Hilaire (father) and that of p 631ᵇ Isidore Geoffroy Saint Hilaire (son)

Isidore's father and later his antagonist, almost always referred to Étienne Geoffroy St. Hilaire as "M. Geoffroy." In bibliographies and catalogues the respective names are to be found under Barthélemy and Geoffroy.

These are certainly very few and really unimportant blemishes to a work of such general excellence. Before the appearance of the volume, the English-reading peoples were far behind the French and Germans in versions of the "History of Animals." Now we are ahead of all and it will probably be long before it can be superseded by another. Before such shall be the case, the fauna of Greece must be thoroughly explored and doubtless in some sheltered nooks names of animals that have perished in places investigated may be still found in use as in Aristotle's time but under variant modifications. Meanwhile, we shall have reason to congratulate ourselves on the superiority of that which we have.

THEO. GILL

NOTES ON METEOROLOGY AND CLIMATOLOGY

THOUGH authorities agree that climate is practically unchangeable, except when geological time-units are considered, this problem, and especially the corollary relating to mild winters and severe springs, has aroused considerable discussion. The backwardness of spring during the last few years in many parts of the United States has caused considerable alarm among those who are directly affected. In Missouri orchardists have begun to question the policy of continuing the attempt to raise fruit on an extensive commercial scale. In view of these facts, Mr. George Reeder, section director of the United States Weather Bureau, made a study of the cause of the alarm. His investigation has been summarized in a paper, "Late Spring Frosts in Relation to the Fruit Crop of Missouri," which was read at the January meeting of the Missouri State Horticultural Society. It is reprinted in part in the *Monthly Weather Review* for December, 1910. He points out the fact that the daily minimum temperature, rather than the mean temperature for the day, is the important factor, for it is the extreme minimum rather than the mean daily temperature that affects vegetation most. As far as minimum temperatures are concerned, the springs of the last ten years, and particularly the last five years, averaged colder than those of the preceding fifteen years. Not only is the average of the daily minimum temperatures for April and May lower in the last decade than in the preceding two decades, but the frequency of freezing temperatures during these months has been greater of late than formerly. While this is an apparent substantiation of the popular notion that "our climate has changed," he cautions the reader from drawing such a conclusion, suggesting that these changes occur in cycles or oscillations. Data for a sufficiently long period are not available for determining the lengths of these cycles, or for forecasting a change in the present conditions. In conclusion he says, "The popular idea that the climate is changing is evidently an old one, and is caused by the temperature and precipitation conditions remaining for comparatively short periods below or above the normal conditions, such changes should be referred to as oscillations in the weather rather than as changes in the climate."

"The Practical Application of Meteorology to Aeronautics," a paper which was read by the author, Mr. W. H. Dines, before the Aeronautical Society of Great Britain, appears in the *Aeronautical Journal* for January. He showed that the density, the temperature and especially the motion of the atmosphere are of considerable importance to the aviator. The decrease in density of the air with height results in a loss in supporting power, but since the actual resistance to forward motion becomes less, greater speed is possible. The decrease of temperature with height renders it necessary for the aviator to wear thicker and therefore heavier clothing. However, by far the most important consideration in this connection is the wind, both in respect to velocity and to direction. Wind affects aviation in two ways, (1) by its actual presence, and (2) by its steadiness or gustiness. From data obtained by means of kites and balloons, certain

principles have been recognized For example, if one knows the barometric gradient at the ground he can compute approximately the velocity of the wind for moderate heights with the aid of Ferrel's formula and the known rate of increase of velocity with height Moreover, the change of wind direction with height can be foretold when one's position with respect to the barometric distribution is known Such information is of value both to the aeronaut, who in the free balloon seeks a desirable current by ascending or by descending, and to the aviator, who in an aeroplane can travel more advantageously with the wind than against it In the opinion of Mr Dines, progress in the art of mechanical flight depends largely upon meeting and overcoming the difficulty of the gustiness of the wind Many accidents have had their origin in this condition, which is always present in a more or less degree When it is serious enough to render flying hazardous the professional aviator aptly says that the air is "full of holes" In various ways it has been determined that the wind becomes steadier with increasing height, except within the stratum of fracto-cumulus clouds, when they are present Increased speed does not result in increased stability unless the construction of the aeroplane is proportionately strengthened These, and other facts based upon the meteorological data of Blue Hill Observatory are shown graphically, as well as verbally, in a book called "Charts of the Atmosphere for Aeronauts and Aviators," which is now in the hands of the publisher, John Wiley and Son, of New York.

A TEMPERATURE model, the second of its kind,[1] has recently been completed by Mr Eugene Van Cleef, of Chicago. Based upon the data for the period 1890 to 1910, inclusive, it shows in relief the average hourly temperatures for that city Of plaster-of-paris construction, it is two feet long and one foot wide Vertical lines at inch intervals are drawn upon the two narrow sides to represent the months of the year, while similar lines drawn upon the other two sides represent the twenty-four hours of the day The vertical dimension of each point upon the upper surface of the model represents temperature, each sixteenth of an inch representing one degree, the base being zero degrees Fahrenheit The upper surface is anticlinal, and is colored to show the four seasons of the year The model is instructive in many ways, the more striking features shown consisting of (1) the diurnal periodicity of temperature, (2) the change in the occurrence of the daily minimum temperature from about 6 A M during winter to 4 30 A M in summer, (3) the change in the occurrence of the maximum temperature of the day from about 3 P M in winter to about 1 P M in summer, and (4) the more rapid increase of temperature from spring to summer than the decrease from autumn to winter

[1] See SCIENCE, Vol. XXXI., No 807, p 954

IN the neglected field of phenological climatology a noteworthy contribution has been made by Dr E. Vanderlinden in his "Etude sur les phénomènes Périodiques de la Végétation dans leurs Rapports avec la Variations climatiques" The latter describes the results of a study of the relation between climate and the flowering-date of thirty-nine plants, as observed at the Royal Observatory gardens in the suburbs of Brussels, during the fourteen years, 1896 to 1909, inclusive Though the observer was the same throughout the period, all of the plants were not observed each year. The first appearance of the stamens was taken as a basis, since leaves and seeds develop irregularly When possible, artificial conditions were produced to verify conclusions based upon the observations of the effects of similar natural conditions The effect upon the flowering date of a plant by departures from the mean of the various meteorological elements affecting its growth was the real object of the study Rainfall and atmospheric humidity had less effect in this respect than is generally supposed to be the case Radiation, too, especially during the spring months, is comparatively unimportant By far the most effective factor in determining the time of florescence is the temperature, though its importance varies with the different stages of the plant's life. Varieties accustomed to mature at about the same time are affected

similarly by departures in the average weather conditions Though the approximate date of flowering is determined by heredity, the weather conditions of the preceding season, when the seeds are maturing, have no effect When the flowering stage is delayed because of unfavorable conditions, a change to more favorable weather will bring out the flowers with a less amount of "accumulated temperature" than otherwise In general, Dr Vanderlinden concludes that temperature and insolation outweigh all other climatic factors in the development of the plant up to florescence

Having been successful in the recovery of sounding-balloons previously sent up at Omaha, Neb, the United States Weather Bureau again used this station as a base of operations in a series of daily ascensions from February 7 to March 3 As it is necessary to recover the instrument carried by this form of balloon in order to get the desired record, the starting point must be well inland, as the prevailing wind aloft invariably blows the balloons eastward At Mount Weather Observatory, which is unsuitably located for this particular work, pilot balloons have been used since March 1 to supplement the kite flights on the days set apart for international cooperation in aerological exploration No attempt is made to recover these balloons, as they carry no instruments By observing them with transit-instruments until they disappear, the velocity and the direction of the wind are obtained They have been used successfully for this purpose at Blue Hill Observatory since 1909

Though it has generally been supposed that the rain gauge was invented by Castelli in the early part of the seventeenth century, recent discoveries seem to indicate that it was in use in Korea at a much earlier date In Volume I. of the "Scientific Memoirs of the Korean Meteorological Observatory," Dr Y Wada, the director of the newly established weather service of that country, states that in 1442 King Sejo had a cylindrical bronze gauge, about 12 inches high and 5 inches in diameter, in which the depth of the water was measured after each occurrence of precipitation In one which he has found, the cylinder stood in a depression in a boulder upon the sides of which an inscription gave the year and stated the purpose of the gauge Though similar instruments were later used in other parts of the same country, Dr Wada has been unable to recover any of the records, which were doubtless preserved for a time The latter would be exceedingly interesting and valuable at present in furnishing data concerning climatic changes Korea is a land of deficient rainfall now, and the special efforts made to measure it five centuries ago would seem to indicate that it was an important factor in the welfare of the people even at that early date, suggesting similar conditions then

"Dynamic Meteorology and Hydrography," by Professor V Bjerknes, of the University of Christiania, and various collaborators, has recently been published by the Carnegie Institution of Washington The greater part of the volume consists of exhaustive discussions, in nine chapters, of the more important problems in statics Diagrams, tables and mathematical demonstrations are generously employed to make clear some of the complex problems treated The remainder of the book consists of hydrographic and meteorological tables On account of the abstruse nature of the matters discussed, not many will appreciate the value of the work, but advanced students will doubtless find it a notable contribution

Two interesting discussions of the cold of winter anticyclones are found in *Symons's Meteorological Magazine* In the March number Mr W H Dines states that according to the Greenwich records for the fifty years, 1841 to 1890, inclusive, a considerably larger number of days of frost occurred when the mean barometric pressure was below 29 80 inches than when it was above 30 20 inches During that period nearly every frost noted for severity or length occurred in the low pressure series. The statement concerning the supposed cold in winter anticyclones in many text-books he says is not substantiated by evidence, and he suggests that the idea "may

have come from the mistaken notion that an anticyclone brought down air from the upper strata, and therefore ought to be cold. The descending air does occur, but the temperature during an anticyclone a few hundred feet high is unduly warm." In the April number Dr. J. Hann points out the fact that it is not the absolute height of the barometer that is determinative in locating anticyclones, but rather the relative height of the barometer compared with that of the surrounding districts. He maintains that the center of an anticyclonic area is cold in winter, "a focus of cold"—an opinion supported by the investigations of Hildebrandsson on temperatures in cyclones and anticyclones. "The cold arises in winter in anticyclonic regions as a result of radiation favored, in a high degree, by the clear skies and the dry air of the anticyclonic center. One can say definitely that the cooling of the earth in the winter half-year is accomplished mainly in the anticyclonic areas of the land surface. Nocturnal radiation is very intense in the dry air, especially when the surface of the ground is covered with snow." The extremes of the winter months in central Europe show no constant relation to the variations of pressure in central Europe itself, as the "focus of cold" is usually at the center of a persistent continental anticyclone to the northeast. Only in exceptional cases is central Europe itself the seat of this center, and when it is, abnormally cold weather is experienced. As the British Isles usually remain on the western side of the European anticyclone, and thus have southerly and southeasterly winds with high barometer, it follows that high temperatures quite often accompany the high barometer. At the same time, however, it is cold on the continent in the center of the European anticyclone.

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BLUE HILL OBSERVATORY,
April 25, 1911

THE SOIL, A LIVING THING

FOR many years the fertility of the soil was sought in the chemical substances which analysis proved to be essential to plants and which could be exhausted from the soil by the continual growth of a single crop upon it. To restore the fertility of the soil, it was necessary only to restore the ingredients necessary to keep a plant in a productive condition. Fertilizers were applied which were known to contain the most important materials of plant food and in an available form. Even to-day, there are opposing camps of plant physiologists. One set holds to the principles, first clearly enunciated by Liebig, that the chemical condition of the soil is the most influential factor in the productivity of the garden, or farm. The other group consider that the physical condition of the soil influences the tilth. This school teaches that all agricultural soils contain sufficient quantities of the essential mineral plant foods for many years to come. Recently a more advanced position has been taken by some students of the soil, when they claim that the loss of fertility of many long cropped soils is due to the accumulation of toxic bodies, the accumulated excreta of plants that may have been grown without proper rotation. The true theory of soil fertility will probably be found to be one which will combine all of these theories with another one, which I believe must also be considered in reaching a satisfactory conclusion as to the relation existing between crops and the soil in which they grow.

The theory is one which considers that the soil is a living thing apart from its chemical or physical structure, that in the reaction between the living soil and the growing plant is the true explanation of soil fertility. A fertile soil is a live one. An infertile soil is a dead one. Contrast the soil which is filled with organic matter (humus) and in which numberless fungous, bacterial and protozoan organisms are at work with a mass of clay or sand without such organic material and associated living organisms. The one soil is fertile, because the organisms in the soil react favorably upon each other, the other soil is infertile, because the organisms present in this soil are antagonistic. Recent investiga-

tion has pointed the way along which future research on soils must proceed and some of this instructive work may be reviewed here briefly and in a sequence which suggests the orderly manner in which effect follows cause.

Harter[1] in a paper entitled the "Starch Content of Leaves dropped in Autumn" has shown that the well-established belief that autumn leaves contain very little carbohydrate in the form of starch and sugar is erroneous, for during the summer of 1909, he undertook to trace the change taking place in the amount of starch formed in the leaves of *Liquidambar styraciflua* at different periods, viz., August 17, September 15, October 23 and October 28. On October 28, the leaves were collected which had fallen recently from the tree. The starch in the leaves collected at the different dates was determined quantitatively and was found to be as follows: August 17, 10.91 per cent.; September 15, 10.33 per cent.; October 23, 11.47 per cent. and October 28, 10.79 per cent., based on the dry weight of the material. Since so much starch was found in the fallen leaves of the sweet gum similar material was collected from several other plants and the starch determined as above. The amount of substances in the leaves capable of reducing the copper in Fehling's solution, as determined by the above method, are shown in the table:

	Per Cent
Liquidambar styraciflua	10.79
Gingko biloba	6.32
Platanus orientalis	11.84
Platanus occidentalis	9.89
Styrax americana	5.91
Magnolia obovata	7.19
Quercus pedunculata	14.54
Elæagnus umbellata	10.24

The thought suggested to me after reading the results of Harter's work was one which considered the final disposition of the starch in the fallen leaves. Is this starch disintegrated, or is it changed into a form by which it can be utilized by the roots of forest plants and by the organisms of the soil? To answer this question, I would call attention to the studies of a graduate student of mine, who in a recent piece of work on "Bacteria and other Fungi in Relation to the Soil" has discovered the ultimate destiny of this carbohydrate material. Dr. Rivas[2] by a detailed analysis of the bacterial content of virgin forest soils has shown that the largest number of bacteria are found during October, and the least number during the winter months. He finds that the forest soils contain bacteria which produce enzymes capable of fermenting the carbohydrates, as shown in the following tabulation of his results, which shows the relative proportion of the different ferments produced by the species isolated:

	Per Cent
1. Diastatic ferment acting on starch, found in 24 cultures	60.0
2. Inverting ferments, inverting starch or saccharose into glucose found in 29 cultures	72.5
(A) Inverting starch into glucose found in 22 cultures	55.0
(B) Inverting saccharose into glucose found in 14 cultures	35.5

The presence of these organisms in the soil clearly points to the fact not previously considered in the study of forest soils, that the starch found in autumn leaves can be converted directly by such soil organisms into glucose, and it is probable that this sugar is directly absorbed by the roots of higher plants (a fact not previously suspected), either by the root hairs, or by means of the mycorhiza found abundantly on the roots of many forest trees. Such sugar is also utilized by non-chlorophylless plants, saprophytic fungi (*Agaricus*), and flowering plants (*Monotropa*), for it has long been known these plants can absorb the whole of their organic food (including the soluble carbohydrates) from the humus and that the various mycorhiza living in commensalism with the roots of phanerogams are probably of considerable importance in render-

[1] *The Plant World*, 13: 144–147, June, 1910.

[2] "Contributions from the Botanical Laboratory of the University of Pennsylvania," III., 243–274.

ing the humus available. Saida[3] has shown that the parasitic fungus *Phoma betæ* can fix nitrogen in the presence of cane sugar, as follows:

Substances Added to a Nutrient Salt Solution	Cane Sugar in Grams	Fixation of N in Milligrams
Cane sugar	5	.7393
Cane sugar	17	1.1828
Cane sugar (+ $(NH_4)_2CO_3$ trace)	5	1.1828
Cane sugar (+ $(NH_4)_2CO_3$ trace)	10	1.7742
Cane sugar (+ $(NH_4)_2CO_3$ trace)	20	3.5184
Cane sugar (+ $(NH_4)_2CO_3$ trace)	30	6.2097

More recently Ternetz[4] has isolated five endophytic mycorhizal fungi from certain Ericaceæ, all of which have been found to belong to the genus *Phoma*. Three of these organisms, *Phoma radicis oxycocci*, *Phoma radicis vaccinii* and *Phoma radicis andromedæ*, have shown a well-developed capacity for nitrogen fixation in culture, these three mentioned working even more economically than *Azotobacter chroococcum*, the amount of nitrogen fixation in milligrams per gram of dextrose being under the conditions of culture, respectively 22.14, 18.08, 10.92 and 10.66 for the four organisms mentioned.

With these discoveries in view, we can briefly summarize. The starch in fallen autumn leaves is converted by certain forest soil bacteria into glucose. This glucose is utilized directly by the roots of forest trees, by various saprophytic plants and by the mycorhiza, which by the aid of the glucose are enabled to fix considerable amounts of nitrogen. That the soil is the seat of other activities of as much importance to growing plants, as the above, is proved by the presence of the nitrifying and denitrifying bacteria, of the bacteria that produce the root nodules of the Leguminosæ, of such organisms as *Clostridium pastorianum*, *Bacillus mycoides*, *B. ellenbachensis*, *Azotobacter chroococcum*, *A. Vinelandii* and the hyphæ of numerous saprophytic fungi, various putrefactive bacteria, which perform their rôle in making the soil the fit habitation of the higher flowering plants, producing the tilth or "Bodengare" of the Germans. So too earthworms, insect larvæ, ants and burrowing animals assist in the task of aerating and mixing the surface layers of the soil. It is also evident that the production of toxic excretions by the roots of plants is undoubtedly a factor of importance in soil fertility. Following out a clue which the partial sterilization of the soil by chemicals or by steam gave, it was discovered that the bacteria which are useful in ammonia-making increased four-fold after such treatment, suggesting the presence in the soil of some agent which held them in check. After much painstaking study it was discovered[5] that the soil contained a living protozoon (*Pleurotricha*), which preyed upon the useful organisms, and that the heat and chemicals either destroyed these larger unicellular animals, or inhibited their activity. It can be said, therefore, that the fertility of the soil is largely a biological one, as well as dependent upon the physical, chemical and toxic condition of the surface layers. That the productivity of some soils is due to biological rather than to physical and chemical characteristics is illustrated by the attempts made to reforest Denmark. The peninsula of Jutland was covered originally by forests, but these were destroyed, until by the year 1500 the country had been transformed into a barren heath and sand dunes. At various times attempts were made to reforest these heaths but the results were disappointing until Col. E. Delgar[6] solved the problem. Spruce trees (*Picea alba*, *P. excelsa*), if planted alone did not thrive, but became sickly. The cause of this irregularity in the growth of spruce was thought to be local conditions of the soil, but scientific investigation of such soils did not reveal any

[3] "Ueber Assimilation freien Stickstoffs durch Schimmelpilze," *Ber. d. deutsch. Bot. Ges.*, 19: 107–115, 1901.

[4] Duggar, B. M., "Fungous Diseases of Plants," p. 74; Ternetz, Charlotte, "Ueber die Assimilation des atmosphärischen Stickstoffes durch Pilze," *Jahrb. f. wiss. Bot.*, 44: 353–408.

[5] Hall, A. D., "The Soil as a Battleground," *Harper's Magazine*, October, 1910, pp. 680–687.

[6] Hovgaard, William, "The Reforestation of Denmark," *American Forestry*, XVI., 525–529, September, 1910.

difference in the physical or chemical composition of the soil. It was found, however, that the mountain pine (*Pinus montana*) acted as a nurse to spruce trees planted in its vicinity. In the same soil where spruce if planted alone would remain backward, it would if planted close to a mountain pine grow up vigorously. After some years of trial, it was found that the pine would hamper the growth of the spruce, and so it was cut down at an early age. It was discovered then that even if the mountain pine was cut down at an early age, it imparted to the adjacent spruce trees the ability to grow. The phenomenon is not understood, but it is supposed that the roots of the mountain pine are inhabited by some mycorhiza which produces the nitrogen necessary for the growth of trees and that this organism is transferred to roots of the surrounding spruce trees. Once this infection has taken place, the presence of the mountain pine is no longer necessary and it is usually cut down. Clearly this is a biological relationship.

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SPECIAL ARTICLES

OOSPORES OF POTATO BLIGHT

THE potato blight fungus, *Phytophthora infestans*, has attracted more attention from botanists than almost any other fungus. The reasons for this are that under certain climatic conditions it causes sudden and widespread destruction of potato fields, and also that, though its life history has been carefully studied, the sexual or oospore stage has never been surely found. Berkeley, who was one of the earliest investigators to have a rational view of the cause of the epidemic of 1845, wrote at the time as follows:

> Few subjects have attracted more attention or have been more variously canvassed than the malady with which potatoes have been almost universally visited during the autumn of 1845. The press has teemed with notices the most contradictory, the attention of scientific men in every direction has been engaged by it, and three, at least, of the principal governments of Europe have issued commissions to examine into its etiology, and to discover, if possible, a remedy.

In 1875–76, at a time of considerable devastations of potato crops in Europe by the fungus, DeBary was employed by the Royal Agricultural Society of England to further investigate this fungus, while at about the same time Worthington G. Smith was engaged in similar work for the Royal Horticultural Society. As the result of their endeavors, considerable was learned concerning the life history of the fungus. Smith claimed to have found the oospores in the infested leaves and the old sets in great abundance, and was awarded a gold medal by the Royal Horticultural Society for his work. These bodies had been observed as early as 1845 by Rayer, Montagne and Berkeley. DeBary did not succeed in finding what he considered oospores of this fungus, and disputed Smith's claim with such good reasons that botanists generally believe that the oospores have never been discovered, though once or twice since investigators have claimed, without much conviction, to have found immature oogonia.

At the time of the controversy DeBary said:

> Ever since the oospores of a *Peronospora* were discovered, innumerable researches have been made for those of *Phytophthora*. I have myself looked for them for fifteen years, and on every opportunity have searched for them in the stalks, leaves, flowers, fruit and tubers of the potato. In July of the present year (1875), when the fungus appeared in this district in sad abundance, I obtained a very large amount of material for study, and at the same time secured the kindly assistance of two botanists experienced in researches of this kind, Dr. Rostafinski and Dr. Stahl. But again only negative results were arrived at. . . . That they will be regularly found somewhere or other is assured, for our knowledge of the habits of numerous allied fungi make this more than probable.

Smith deposited slides of his oospores with the British Museum. Concerning these Massee some time ago wrote me:

> I have very carefully examined W. G. Smith's type slide preparation, and am positively certain that the so-called oospores are nothing more than

the globose, thick walled chlamydospores belonging to a Fusarium

In a discussion following the Jones and Lutman paper at the American Association for the Advancement of Science meeting at Boston last year, Gussow said that he had seen these slides, and that the oospores much resembled the bodies that Jones and Lutman had obtained in their artificial cultures The writer has not seen these slides, though he tried to obtain examples of the oospores from Smith a few years ago Smith wrote at that time

> No doubt you know that the oospores became a kind of political subject—oospores of *P infestans* or not oospores of *P infestans*?—and I had no wish to go on Botanists and popular writers followed what they took to be the safer authority, just as Saccardo has done, this is right enough in a way

While we have not seen these slides, on every possible occasion during the eight years that we have been studying this fungus, we have looked for oospores in the leaves and tubers under the conditions described by Smith While we have never found spores that satisfied us that they were the potato blight oospores, we have found oospore-like bodies, both of animal and fungous origin, that might be mistaken for such, and possibly might be some of those bodies described by Smith We have seen Smith's drawings, and his photomicrographs published in the *Quarterly Journal of Microscopical Science*, Vol 15, in 1875, and the drawings of Montagne, published by Berkeley in the *Journal of the Horticultural Society*, Volume 1, in 1846, these latter being considered by Smith to represent the same thing he described as the oospores None of these impress us as being the same as the true oospores that we have obtained in cultures The only figures that at all show a resemblance are Figs 134 to 136 in Smith's book on "Diseases of Field and Garden Crops," published in 1884 We are inclined to believe that these botanists had a variety of things under consideration, and while it is quite doubtful if any of them were the oospores of potato blight, we do not wish to make a positive assertion without seeing the original preparations

In 1904 we first began to study the potato blight in artificial cultures So far as we know, we were the first to make such cultures in this country, or at least to publish notes on them,[1] but in looking up the literature at the time, it was found that two French botanists, Matruchot and Molliard, had secured cultures even earlier Their results, published in 1900 and 1903, were similar to those we had obtained, viz, the fungus was grown in certain media with fair success, but no oospores appeared, though we did very rarely find curious-shaped threads that might indicate futile attempts to form oogonia

At the Baltimore meeting of the American Association for the Advancement of Science, in December, 1908, Jones and Giddings gave a paper[2] in which they described these curiously shaped threads which had appeared with more or less frequency in stab cultures of a specially prepared potato-gelatin medium that they used Jones was inclined to believe that they were attempts at oogonial formation, though there were no indications of antheridia or oospores At the same meeting the writer[3] described a special medium, Lima bean juice agar, on which the potato blight grew with far greater vigor than on any medium yet tried, so that its continued cultivation was as easy as that of any parasitic fungus On this medium, however, no oospores appeared, and very rarely even the curious-shaped threads, though when *Phytophthora Phaseoli*, a near relative, was grown on it, oospores appeared in profusion

At the Boston meeting of the American Association for the Advancement of Science, Jones and Lutman gave a second paper[4] in which they further discussed these curious bodies that appeared in their cultures Though not stating positively that these bodies were of the nature of oogonia, they were inclined to consider them as resting spores While much

[1] Conn Agr Expt Sta Rept, 1905

[2] SCIENCE, XXIX, 271, February 12, 1909

[3] Conn Agr Expt Sta Rept, 898, 1908

[4] SCIENCE, XXX, 813, December 3, 1909

more successful in producing these bodies than previously, due in part to the use of the lima bean medium in a modified form, and while these bodies showed a still greater modification toward the oogonial type, they did not succeed in producing in their cultures any bodies of the nature of antheridia.

During the past year the writer, with the aid of his assistant, Mr E M Stoddard, has made still further tests with four strains of potato blight obtained from different sources, and with two of these (really one, as the other traces back to the same potatoes one season later) has obtained results far beyond anything yet reported These results were primarily due to the use of a new medium, which gave us for the first time very definite attempts at oospore formation, and with a certain modification of this medium *absolutely perfect oogonia, antheridia and even oospores have been obtained* We have not been successful, as yet, in producing the oogonia in cultures in anything like the abundance of those of *Phytophthora Phaseoli* and *Phytophthora cactorum* in the same medium, and very few of the oogonia produce even partially mature oospores, but of their nature there can be absolutely no doubt Whether or not we can perfect their formation in greater abundance remains to be seen, but recently, from an unusually good culture, a temporary slide preparation showed over a hundred of these oogonia, mostly without oospores or with immature ones; whereas last March the most we could find in similar slides were half a dozen or less

From the results of our recent investigation there is no doubt that the curious threads and bodies that Jones, and the writer to a much less extent, previously obtained, were attempts at the formation of oogonia We should judge, however, that Jones's cultural media, except for one particular, were not suited to perfect these bodies further, and that the excretory markings he obtained on the cell walls were largely abnormal. From my investigations it can be stated that the oogonia of the potato blight are thick-walled, with a more or less roughened or ornamented external coat, due to excretory thickening of the original wall, and are tinted more or less a chestnut brown The oospores are moderately thick-walled, smooth and colorless The oogonia are of a quite different type from those of both *P Phaseoli* and *P cactorum,* which are similar. The oogonia and oospores of these two are somewhat smaller than those of *P infestans,* but the chief difference is their smooth, hyaline, thin-walled oogonia

Not only has the writer obtained the oospores of *P infestans* in pure cultures, but he has also succeeded in raising what he considers crosses of this fungus with both *P Phaseoli* and *P cactorum* by inoculating a test-tube of the special medium with *P infestans* at the top and one or the other of these two species below With the growth of the two colonies together there appear in the vicinity of the *P infestans* colony not only the oospores of the other fungus but also oospores of the *P infestans* type These oospores of the *P infestans* type so far appear only rarely in the crosses with *P cactorum,* which, however, have only recently been made In the crosses with *P Phaseoli* the oospores of the *P infestans* type are more abundant than they have ever yet appeared under the most favorable conditions in pure cultures of *P infestans,* and many of them produced perfect oospores On the whole the oogonia and oospores appear to be somewhat larger and less deeply tinted than those from the pure cultures of *P infestans* Crosses between *P infestans* and *P. Phaseoli* made last March still continue to produce oospores of the *infestans* type, not usually as abundant as those of the *Phaseoli* type, however, though these cultures have been renewed six times since their original crossing These descendants are not from the oospores, since they never germinate in the cultures

From the data at hand it looks as though there were not two strains (male and female) of the potato blight, as we suggested some time ago, but that the potato fungus had largely lost its power to reproduce itself sexually. This loss may have come about by propagating it year after year asexually

through its hibernating mycelium in the potato tubers, just as the potato itself has largely lost its power to reproduce sexually through the formation of seeds This loss of sexual power is shown in different degrees by the different strains of the fungus in artificial cultures The fungus seems to lose first its power of producing antheridia and then of producing oogonia Under favorable conditions attempts to form oogonia first appear, and under still more favorable conditions the antheridia are produced, and with the formation of these the oospores also appear in more or less perfect form

A further discussion of this subject, with photomicrographs of the sexual stages as we have gradually developed them, will appear in the next report of the Connecticut Agricultural Experiment Station

G P CLINTON

NEW HAVEN, CONN,
December 20, 1910

A POSSIBLE LINE OF DESCENT OF THE GOBIOID FISHES

Indicating the doubt existing as to the relationship of the gobies are the several different positions assigned to them in the schemes of classification suggested from time to time by different authors Without attempting anything like an exhaustive survey of the disposition of the group by different authorities its treatment by a few of them may form an introduction to the suggestions of relationship in the following lines

Dr Gill, in his "Arrangement of the Families of Fishes,"[1] places the superfamilies Gobioidea and Cottoidea in adjoining groups But in his later arrangement[2] he has several families interposed between the Gobiidæ and Cottidæ, as the Batrachidæ, the Uranoscopidæ, the Trachinidæ, the Malacanthidæ and others

Dr Jordan, in his "Guide to the Study of Fishes,"[3] has placed the gobies near the cottoid fishes with the following remark "The great family of Gobiidæ, having no near relations among the spiny-rayed fishes, may be here treated as forming a distinct suborder"

Dr. Boulenger, in the Cambridge Natural History,[4] places the Gobiidæ between the Kurtidæ and Echeneididæ, and expresses the opinion that the gobies "are not very remote from the Perciformes, and may have evolved out of a type not very different from the Percidæ"

Mr Regan, in his classification of the teleostean fishes,[5] has placed the suborder Gobioidea between the Blennoidea and the Kurtoidei

Recently while examining the skeleton of *Dormitator maculatus*, a large goby from the warm waters of the American Pacific and Atlantic, I was impressed with the similarity of its shoulder girdle with that of the family Cottidæ and certain other cottoid or mail-cheeked fishes In light of the fact that there is otherwise very little in the anatomy of the gobies that might show their line of descent, I wondered that the line from some ancestor of the Cottidæ had not been long ago suggested, more especially as there seems to be little reason why such relationship should not exist.

The similarity of the shoulder girdles of these families has long been known As early as 1865 Dr Gagenbaur published a picture of the shoulder girdles of a gobioid and a cottoid fish side by side in the second part of his "Untersuchungen zur Vergleichenden Anatomie der Wirbelthiere."[6]

The condition of the shoulder girdle in the Cottidæ and Gobiidæ is as follows The coracoid elements and the actinosts are arranged in a continuous row on the posterior edge of the clavicle, the hypercoracoid above, next the actinosts, and ending below with the hypocoracoid—the actinosts attached directly with the clavicle, and separating the coracoid elements widely from each other. In the typical condition—the condition in the great majority of fishes—the coracoid elements are broadly attached to each other, and the actinosts are attached to their posterior edges remote from the clavicle

[1] "Smith Miss. Col.," 1872

[2] *Mem. Nat Acad. Sci*, Vol VI, pp. 127–138

[3] Henry Holt and Co, 1905.

[4] Macmillan and Co, 1904

[5] *Ann. Mag Nat Hist*, Ser 8, Vol III, 1909

[6] *Hemitripterus acadianus* and *Gobius guttatus*, Taf VII, figs 8 and 9

The fact that all of the mail-cheeked fishes do not have the coracoid elements separated by the actinosts is not an argument in disfavor of the relationship of the Gobiidæ to the Cottidæ, because the mail-cheeked fishes with the typical shoulder girdle (such as the Scorpænidæ) were, of course, the ancestors of the Cottidæ. From the Cottidæ came the Liparidæ and the Cyclopteryidæ, as Dr. Gill long ago pointed out.[7]

It does not seem improbable that the gobies may have come from some ancestor—probably scale-covered—of the Cottidæ in which the shoulder girdle had become differentiated. Further, it is not altogether improbable that this ancestor might also have been from somewhere along the line leading towards the Cyclopteryidæ and the Liparidæ, some form in which the ventrals had just become attached to each other, much as in most of the gobies of to-day. From this the sucking disk of the Liparidæ and Cyclopteryidæ could have developed. In considering this supposition, of course, we could only explain the gobies with separate ventrals by the separation being secondary. The gobies further resemble the last two families in having no myodome to the cranium.

It is conceded, certainly, that the family Gobiidæ is not very close to the Cottidæ, they having lost the suborbital stay to the preoperculum and undergone other changes, and no modification of the suborders containing these two families is suggested. The character of the shoulder girdle seems to be the most significant character in showing a possible line of descent of the gobies, and it is suggested in light of it that the group be placed in close relationship with the mail-cheeked fishes in works involving classification. With this question in mind the gobies should, of course, be studied in detail.

EDWIN CHAPIN STARKS

CARCHARIAS BORNEENSIS AND BARBUS ELONGATUS, AS PREOCCUPIED NAMES

IN the *Philippine Journal of Science*, Vol. V, No. 4, Section D, October, 1910, p. 263, Pl. 1, Mr. Alvin Seale describes, as new, "*Charcharias borneensis*." This is preoccupied by *Carcharias (Prionodon) borneensis* Bleeker, *Act. Soc. Sci. Ind.-Neerl.* (Borneo 12), V, 1858–59, p. 8.

In the same journal Mr. Seale also describes, as new, *Barbus elongatus*, on p. 265, illustrated on Pl. 2 as Fig. 1. This is preoccupied by *Barbus elongatus* Ruppell, Mus. Senckenb., II, 1837, p. 11, Pl. 2, Fig. 1.

HENRY W. FOWLER

ACADEMY OF NATURAL SCIENCES,
PHILADELPHIA, PA.,
February 9, 1911

[7] *Proc. U. S. Nat. Mus.*, Vol. XIII., 1890.

SOCIETIES AND ACADEMIES

THE PHILOSOPHICAL SOCIETY OF WASHINGTON

THE 693d meeting was held on April 8, 1911, President Day in the chair. Three papers were read:

Mechanical Forces on an Electrical Conductor: DR. FRANK WENNER, of the Bureau of Standards.

Starting with the equation for the electromotive forces in an inductive circuit the speaker showed how it follows under certain conditions that a current through a conductor causes forces such as to require a tension in the conductor to maintain equilibrium, that is, the forces tend to increase the length of the conductor. It also follows that under other conditions the forces are such as to tend to decrease the length of the conductor. Under most conditions the force on an element of the conductor near the surface is such as to tend to crowd it toward the center.

It was also stated that it is possible that a current in a conductor causes forces other than those due to electro magnetic and electrostatic actions, the former only having been considered by the speaker. So far, however, no one has shown the presence of any such additional force.

The Completion of the Texas California Arc of Primary Triangulation: MR. WM. BOWIE, of the Coast and Geodetic Survey.

Three grades of triangulation are recognized: primary, secondary and tertiary; and the grade depends upon the accuracy of the angle and length measurements rather than upon the length of line between pairs of stations.

The primary work is extended in long arcs over

the area of a country to furnish control for the detailed operations The tertiary is used for the immediate control of detailed topographic, boundary and other surveys, while the secondary triangulation is mainly for the purpose of connecting the detached tertiary work with the primary schemes

Owing to the difference which must exist at every station between the geodetic position and the corresponding astronomic position, it is necessary to adopt a mean position called a geodetic datum upon which to reckon geographic positions over the entire country It is the principal object of the primary triangulation to carry standard positions by a connected net to the remotest portions of the area

An incidental purpose of triangulation, and especially of the primary, is to furnish means for determining the shape and size of the earth

In the two recent investigations of the figure of the earth by Mr John F Hayford, while he was inspector of geodetic work and chief of the computing division in the Coast and Geodetic Survey, he applied Pratt's hypothesis of isostasy and he stated that the application of this theory nearly doubled the accuracy of the results

Including about 2,000 miles by the Lake Survey, there are now approximately 11,000 miles of primary triangulation in the United States Recently about 400 miles have been added each year The latest addition is the Texas California triangulation, an arc of over 1,200 miles in length It extends from the 98th meridian triangulation in central Texas to the Pacific coast arc in the vicinity of San Diego It carries standard positions into an area badly in need of control and adds very valuable data for use in a future investigation of the figure of the earth

The probable errors of the observed directions are not available, as the office computations have not yet been made, but we may get a measure of the accuracy of the work by the size of the errors of closure of the triangles The average closing error is 0 9 second of arc, and the maximum error is very little more than 3 seconds This makes the accuracy equal to the average of the best half of the work previously done in the United States

The observations for horizontal measures were made entirely on heliotropes or on signal lamps No serious difficulty was encountered in observing over even the longest lines under average conditions The longest line was 127 miles in length Some of the heliotropes had reflectors 4 and 8 inches square but most of the reflectors were only 2½ inches in diameter The signal lamps burned acetylene gas They were the commercial automobile headlights, modified for use on a stand erected over the station

Some years ago it was believed that a great many observations were necessary to get an accuracy represented by an average closing error of one second and that the observations should be made on a number of different days In recent years only sixteen positions are used, making 32 pointings on each object All the horizontal observations at each of many stations have been made in a single day without materially affecting the accuracy In fact, the average accuracy of the work done under the present methods is greater than the average accuracy of the work previously done

It has been found that the sun effect on the towers, in causing twist, is very slight with the present type of tower, and that the effect, if any, is practically eliminated from the results by the system (always employed) of having a determination depend upon observations made while revolving the instrument clockwise and then in the reverse direction immediately afterwards

The instrument had one horizontal wire and two vertical ones which were 20″ apart It is not necessary for the image to be absolutely stationary for, with practise, one can place the cross wires close to the mean position of the image, even though the object may subtend an angle of more than 20″ and move 10″ to each side of the mean position Observations made under this condition seem to have about the average accuracy

Where the country is flat and the line close to the intervening land the wind tends to cause a distortion of the image It sometimes appears to flare to one side, the flaring being away from what seems to be the nucleus or center of the image In nearly every case where an asymmetrical image is observed the flaring seems to be with the wind Under such a condition it is difficult to make satisfactory observations If the flaring portion of the image is given equal weight with the nucleus a constant error is introduced, while if this flaring part is given no consideration a constant error of the opposite sign is made Such an image is a severe test of the skill of the observer

A remarkable case of lateral refraction was encountered on the twenty mile line joining stations Clayton and Kennard, in Texas This line passed very close to the west slope of a flat topped hill about two and a half miles from Clayton Observations made during several days at Clayton

on Kennard while the wind was blowing from the slope across the line were very unsatisfactory. When observations were made over the line with the wind blowing across it towards the slope of the hill, they were of the required degree of accuracy. The total range in the values for the several observing periods for this direction was about 8" of arc. During each observing period the range of the values for the sixteen pointings was small. It is believed that the air blown from the hill across the line was of a different temperature and was the cause of the lateral refraction.

The large errors in the observed directions of primary triangulation seem to be due to three principal causes. First, to the asymmetrical image of the light or heliotrope caused by wind when the line is low. Second, to lateral refraction, caused by a line passing close to a hillside or mountainside with the wind blowing from the slope across the line. Third, to the very unsteady lights when the instrument is low with the line passing close to the ground near the station. The first two causes produce constant errors, that is, each of the 32 measures is affected in the same direction. The last cause makes large accidental errors.

The Modern Potentiometer: Dr. W. P. WHITE, of the Geophysical Laboratory of the Carnegie Institution of Washington.

For many purposes it is desirable to avoid the slide wire. The construction of potentiometers of wide range in which only switches are used formerly presented difficulties, which have now been overcome. The modern all-switch potentiometer is characterized by three features: (1) the resistance is low, yet the switch contacts introduce no error; (2) the thermo electromotive forces at the switch contact and elsewhere must not cause variations in the reading; (3) the change of setting must not change the resistance of the galvanometer circuit, this in order that the partial deflection method may be employed. These three characteristics can not only be readily secured, but can be obtained in a number of different ways, so that three different types of instrument possessing them are now possible.

The main point of difference practically is concerned with the question whether certain switch contacts shall come in the battery circuit or in the galvanometer circuit. If they are in the battery circuit, much more care must be given to keep their resistance low, but this arrangement is best for reducing the thermoelectro forces. With the contacts in the galvanometer circuit, their resistance is unimportant, and the instrument therefore requires less care and attention; the thermoelectric forces can be practically avoided by proper switch construction, so that this arrangement seems preferable in a majority of cases.

(The abstracts of the second and last paper are by their authors.)

R. L. FARIS,
Secretary

THE BIOLOGICAL SOCIETY OF WASHINGTON

THE 383d regular meeting was held April 1 in the lecture hall of the Cosmos Club with President David White in the chair and about a hundred persons present.

Under the heading brief notes and exhibition of specimens, F. V. Coville showed a pot of trailing arbutus (*Epigæa repens*) in full bloom. The plant had been grown in the greenhouse from the seed, and both foliage and blossoms were superior to those commonly found wild.

The following communications were presented:

A Day in the Galapagos Islands: WILLIAM EDWIN SAFFORD.[1]

The arboreous cereus of Charles Island has never been adequately described. It was said by Darwin to resemble *Cereus peruvianus* and compared by Engelmann with *Cereus multiangularis*. It is quite distinct from both these species. The well known *C. peruvianus* has only six to eight longitudinal ribs, while the Charles Island Cereus has sixteen to eighteen ribs. It is doubtful whether *C. multiangularis* is ever arboreous. Weber has described the Charles Island cereus under two names: *Cereus thouarsii*, which he characterizes as a columnar cereus with superimposed joints and pleasantly acidulous purplish-red, plum-like fruit containing soft white pulp and numerous small black seeds; *Cereus galapagensis*, as a plant resembling the arboreous cerei of South America, "with elevated angular stems exceeding the surrounding vegetation." Both of these descriptions apply well to the Charles Island cereus, illustrations of which, in flower, were presented by the author of the paper. The descriptions of both supposed species were published on the same page by Weber, and though *C. galapagensis* may be a preferable name, as it indicates the habitat of the species, *C. thouarsii* precedes it on the page, and must therefore be accepted.

Cereus thouarsii is remarkable for the long slender tube of its funnel-shaped perianth. The

[1] This paper is to be published in *The National Geographical Magazine*.

flowers are borne not near the apex, as in our giant cereus of Arizona, but along the sides of the branches and stems, often growing from areoles of the older or lower joints, solitary, yet often appearing from two or three adjacent areoles. The ripe fruits are very much like the *pitahayas* sold in Mexican markets. They are crowned by the withered perianth.

The joints, appearing in series and separated by abrupt constrictions, are sometimes five or six feet long, shaped like great ears of corn, or like thick-handled ten pins or indian clubs, or they are shorter and oval, resembling a series of melons piled one on top of the other, or they are sometimes spheroid, and the branches often form a divarication from one of the globose articulations. From the illustrations presented it is apparent that the arboreous cereus of Chatham Island is identical with that of Charles Island. It is to be regretted that figures of the flowers of Galapagos Cactaceæ are absolutely wanting thus far, though the islands have been repeatedly visited by scientific expeditions. The older specimens of *C. thouarsii* have stout cylindrical trunks covered with bark which splits into longitudinal strips.

The first description of an arboreous cereus growing in the Galapagos is that of the navigator Dampier, who visited the group in 1684. He described it as "a green prickly shrub ten to twelve feet high, as big as a man's leg and full of sharp prickles in thick rows from top to bottom, but without leaf or fruit." Colnett, in 1793, distinguished the cereus from the opuntia observed by him in the Galapagos, calling the first a "torch thistle" and the second a "prickly pear."

Captain David Porter was the first writer to call attention to the differences of the tortoises on the different islands of the Galapagos. His journal of the *Essex* was published twenty years before the visit of the *Beagle*. Figures were presented of two of the living tortoises from the Galapagos now in the National Zoological Park, *Testudo ephippium*, an example of what Captain Porter called the saddle backed form, and *Testudo vicina* Guenther, with a back of the form likened by Woods Rogers, the old sea rover, to the top of an old-fashioned hackney coach.

The figure of a fossil species, *Testudo osborniana* Hay, from the Miocene of northeastern Colorado, was also shown, and the question as to the possible connection of the Galapagos group with the main land during some part of the Tertiary age was discussed. The fact recorded by Captain Porter that tortoises thrown overboard from captured vessels remained floating and unharmed for several days, though unable to swim, was cited as bearing upon the point of the possible translation of the ancestors of the tortoises from the continent to the islands by ocean currents.

The paper ended with an account of the writer's visit to a hermit living in a cave in the interior of Charles Island, and of the animals which had become wild on the island, some of which had been caught when young and domesticated by the hermit. An account of the garden cultivated by the hermit was also given.

The Keys, Corals and Coral Reefs of Florida: T. WAYLAND VAUGHAN.

Dr. Vaughan gave a short lecture, illustrated by stereopticon views, on the subjects indicated by the title of his communication. He called attention to the extensive submarine plateau, of which the present land surface of Florida constitutes less than one half, and lies near the eastern margin. He briefly described the course of the 100-fathom curve and the steep declivity from it to the depth of 1,500 and 2,000 fathoms in the Gulf of Mexico, whereas between peninsular Florida and Cuba (except north of Havana) the depths are less than 500 fathoms. Between the northern end of the Bahama bank and the east coast of Florida the depth is somewhat less than 300 fathoms. The course of the 10 fathom curve was traced, and the relations it bears to the great barrier reef of Florida were indicated. The Hawk Channel, which lies between the line of reefs and the keys, the keys, and the bays and sounds between the keys and the mainland, were briefly described. A series of photographic slides were shown to illustrate the topography and geology of the mainland in the vicinity of Miami, and the surface features, including the vegetation, of the entire line of the Florida keys. The geologic formations of the region are of Pleistocene or recent age. The keys from Virginia Key at the north to Bahia Honda are elongated in a curve from northeast to southwest. Then follows the second group of keys including the Pine Keys, and extending to Boca Grande west of Key West are elongated in a direction at right angles to the axis of elongation of the more northerly keys, while the Marquesas and the Dry Tortugas are of atoll form. In composition the keys opposite the northern end of Bay Biscayne have a surface largely of siliceous sand. Those from Soldiers Key to the southern end of Big Pine Key are composed of elevated coral-reef rock—the Key Largo limestone. The keys from the Pine Keys

to Boca Grande are composed of an oolitic lime stone—the Key West oolite, which has been so recently elevated above sea level that its upper surface still shows sun cracks The Marquesas and the Tortugas keys are composed of the comminuted, calcareous tests of organisms

The geologic activity of mangroves in converting shallow submarine banks into land areas was described and illustrated by lantern slide photographs The fruit of these plants, which is a pod about six to nine inches long, falls into the water and catches on the soft ooze of shallow banks, where the young plants begin to grow, and after developing a tangle of roots below and a tangle of branches above the level of the water, catch and retain any drifting débris

The speaker then pointed out how fossil corals were utilized in ascertaining the depth and temperature conditions under which geologic formations containing the remains of these organisms were deposited The restriction of reef forming corals to shallow water and regions of high temperature, and the existence of a different fauna at depths below 100 fathoms and in regions of cooler temperature, were pointed out

Dr Vaughan then briefly outlined the study of the Florida corals, which he is conducting under the auspices of the Carnegie Institution of Washington, with reference to various factors that determine habitat and influence variation He showed that within the shallow water area of southern Florida there are several different faunal groups of corals that live under different conditions There are the reef corals proper, largely of massive type, that grow on the barrier reef Other corals, either of more fragile form of growth with a weaker basal attachment, or with ability to withstand deposits of silt over their upper surface, live on the flats protected from ocean breakers Other corals of a fragile habit of growth live in channels where they have a continuous supply of pure water and are protected from the breakers More fragile corals grow at the outer foot of a reef beneath the level of the pounding of the breakers than on the reef proper The forms that grow at the outer foot of the reef are to some extent similar to those that grow in the channels or along the margin of channels protected from the pounding of the breakers

The subject of the rate of growth of corals was briefly reviewed and the results of the investigations of Professor J Stanley Gardiner in the Maldive Islands were given Professor Gardiner there obtained a collection of corals none of which could have been more than three years of age, and on the basis of these observations estimated that the coral reef might increase one fathom in sixty years The observations of Gardiner are weak in that he did not definitely know the age of the individual specimens he obtained

Dr Vaughan has at present about 200 different coral colonies on which he is making annual measurements to determine the growth rate The colonies comprise the various conditions under which shallow water corals grow around the Tortugas, so that the investigations when completed will give the growth rate for each species investigated, and the variation in growth of each species in accordance with the conditions under which it lives in nature The results of the observations at present indicate that the rate of growth of corals is much more rapid than was previously anticipated, so that in a general way the opinions of Professor Gardiner are substantiated

The technique of obtaining specimens for planting was briefly described Besides those colonies that are naturally growing on the reefs or in other localities a number of specimens have been affixed by hydraulic cement to tiles, and the tiles have been planted on the heads of iron stakes driven in selected localities The tiles can be removed from the stakes, measured and photographed at desired intervals

Dr Vaughan also described the technique of rearing coral larvæ and the planting of the affixed young The larvæ are obtained from living corals brought into the laboratory and kept in jars of water The planulæ are then pipetted into a jar containing sea-water and a tile on its bottom After the planulæ have settled the tile is then planted Some of the tiles with attached larvæ were affixed to iron stakes in the sea and others were attached to the bottom of a floating livecar It has been ascertained that a *Favia* planula may attain a size of 9 mm in diameter within a period of seven months.

The duration of the free swimming larval stage of corals has been carefully studied in order to ascertain the possibilities of drift by ocean currents. The period varies from three or four days to three weeks—periods of ten to twelve days are common These observations have definitely shown that it is possible for coral larvæ to be drifted great distances by oceanic currents if the temperature conditions are favorable

D E LANTZ,
Recording Secretary

April, 1911

SCIENCE

Friday, May 19, 1911

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THE BOLYAI PRIZE[1]

The problems treated by Hilbert are so varied and their importance is so evident that a long preamble seems unnecessary. It is preferable to enter immediately upon the detailed exposition of his principal memoirs. The reader in the presence of results so important will himself draw conclusions.

INVARIANTS

The first works of Hilbert relate to invariants. We know with what passion this part of mathematics was cultivated about the middle of last century and how it has since been neglected. It seemed in fact that Clebsch, Gordan, Cayley and Sylvester had used up all that it was possible to deduce from the old methods and that after them there remained only slight gleanings. But the progress of algebra and arithmetic, and in particular the theory of whole algebraic numbers, the extension soon made of it to integral polynomials, and Kronecker's theory of moduli, made possible the approach of the question from a side still unexplored.

This Hilbert did in attacking at first the celebrated theorem of Gordan, according to which all the invariants of a system of forms can be expressed in a rational and integral way as functions of a finite number of them.

We could not better measure the advance made than by comparing the volume Gordan had to devote to his demonstration with the few lines with which Hilbert has been satisfied. The method gained in gen-

[1] Report on the works of Hilbert by Poincaré. Translated by G. B. Halsted.

erality as much as in simplicity and one could make out a whole series of possible generalizations. A very simple lemma inspired by Kronecker's ideas had made this result possible.

Consider an indefinite series of forms F depending upon n variables, we can find among these a finite number of forms $F_1, \ldots, F_p$, such that any form F of the series can be equated to

$$F = A_1F_1 + \cdots + A_pF_p, \tag{1}$$

the A's being forms depending upon the same variables. This is a consequence of the fundamental notion of the modulus introduced by Kronecker. This means, in Kronecker's language, that the divisors common to many moduli, even were they infinite in number, are submultiples of one of them which is their greatest common divisor, and in geometric language (supposing four variables and regarding them as homogeneous coordinates of a point in space) that the aggregate of points common to an infinite number of algebraic surfaces is composed of a finite number of isolated points and a finite number of skew algebraic curves.

But this is not all, suppose the F's are the invariants of a system of forms and the A's functions of the coefficients of these forms.

We may always suppose that the A's are also invariants, otherwise we could perform an arbitrary linear transformation upon the forms. Then in the relation (1) thus transformed would appear the coefficients of this transformation. In applying to the relation (1) transformed a certain train of successive differentiations (the differentiations are performed with respect to the coefficients of the linear transformation) we reach a relation of the same form as (1) but where the A's are invariants. From this the proof of Gordan's theorem follows immediately.

But this is not all, among these fundamental invariants there is a certain number of relations called syzygies. All the syzygies can be deduced from a finite number of them by addition and multiplication. Among these fundamental syzygies of the first order there are syzygies of the second order, which can also be obtained from a finite number of them by addition and multiplication, and so on.

Hilbert gets this result from a general theorem of algebra. Consider a system of linear equations of the form

$$\Sigma F_{ik} X_k = 0,$$

where the F's are given forms and the X's unknown forms homogeneous in regard to certain variables, the study of the solutions of this system and of the relations which connect them leads to the consideration of a series of derived systems continued until we reach a derived system which no longer admits of any solution. Thus it was that Hilbert was led to determine and to study the number $\chi(R)$ of distinct conditions which a form of degree R should satisfy to be congruent to zero with regard to a given modulus.

But to complete the theory it was not enough to establish the existence of a system of fundamental invariants, it was necessary to give the means of actually forming this, and this problem was made by our author to depend upon a question which connects it with the theory of whole algebraic numbers extended to integral polynomials.

The problem is thus broken up into three others.

1. To find invariants J_m as functions of which all the others can be expressed in *algebraic and integral* form, that is to say, such that any invariant J satisfies an algebraic equation

$$J^k + G_1J^{k-1} + G_2J^{k-2} + \cdots + G_{k-1}J + G_k = 0,$$

the G's being polynomials integral with regard to J_m.

2. To find invariants as functions of which all the others can be expressed rationally.

3. To find invariants as functions of which all the others can be expressed in rational and integral form.

Of these three problems the first is the most difficult. If it be supposed solved, the aggregate of invariants presents itself as an *algebraic corpus*, and the first step to make is to determine the degree of this corpus; this it is at which Hilbert arrives at least for binary forms by evaluating in two different ways the number $\phi(\sigma)$ of invariants linearly independent of degree σ, or rather the asymptotic value of this numeric function $\phi(\sigma)$ for σ very great.

The first problem once solved, the solution of the other two goes back to a classic question of the arithmetic of polynomials and of the theory of algebraic corpora. The question is then to find the fundamental invariants by whose aid all the others can be expressed in algebraic and integral form.

With this purpose Hilbert remarks that these are those which can not be annulled without annulling all the others. So we see that the search for these fundamental invariants will be singularly facilitated by the study of *null forms*, that is to say, of those whose numeric coefficients are chosen in such a way that the numeric values of all the invariants may be null.

In the case of binary forms, the null forms are those which are divisible by a sufficiently high power of a linear factor, but in the other cases the problem is more delicate. Our author first establishes a certain number of theorems.

Consider a form with numeric coefficients and its transform by any linear substitution; the coefficients of this transform will be integral polynomials with regard to the coefficients of the substitution. If the determinant of the substitution is an *algebraic and integral* function of these integral polynomials, the proposed form is not a null form. In the contrary case, it is a null form.

Consider, on the other hand, the transforms of a form by a linear substitution depending upon an arbitrary parameter t and in such a way that the coefficients of this substitution are series developable in positive or negative integral powers but increasing with this parameter. If it be a question of a null form, we can choose a substitution of this kind of such a sort that its determinant becomes infinite for $t = 0$, while the coefficients of the form transformed remain finite. Hilbert shows that this condition is necessary in order that the proposed form may be null, and it is evident, moreover, that it is sufficient. To each null form corresponds therefore one and perhaps several linear substitutions having the enunciated property. This settled our author proves that, starting from any null form, we can by a linear transformation, transform it into a *canonic* null form. A form is called canonic when the linear substitution which corresponds to it and which possesses in relation to it the property we have just stated is of the simple form

$$\begin{vmatrix} t^{\lambda_1} & 0 & 0 \\ 0 & t^{\lambda_2} & 0 \\ 0 & 0 & t^{\lambda_3} \end{vmatrix}$$

The investigation of null forms is thus made to depend on that of canonic null forms which is much more simple. We find that the canonic null forms are those in which certain terms are lacking, and the determination of the terms which should be lacking can easily be made, thanks to a simple geometric scheme.

We see under what a new and elegant aspect present themselves to-day, thanks to Hilbert, problems so many geometers had for fifty years attempted

THE NUMBER e

Hermite was the first to prove that the number e is transcendant, and shortly afterward Lindemann extended this result to the number π

This was a victory important for science, but Hermite's methods were still susceptible of betterment, however ingenious and however original they were, one felt they did not lead to the goal by the shortest way This shortest way Hilbert has found, and it seems that henceforth no one can hope to give new simplification to the proof

This was the second time that Hilbert had given, of a theorem known but only established by means most arduous, a proof of astonishing simplicity This faculty of simplifying what had seemed at first complex thus presents itself as one of the characteristics of his genius

ARITHMETIC

The arithmetical works of Hilbert pertain principally to algebraic corpora The aggregate of numbers which can be expressed rationally as functions of one or several algebraic numbers constitutes a domain of rationality, and the aggregate of the numbers of this domain which are algebraic integers constitutes a corpus If we consider then all the algebraic numbers of a corpus which can be put under the form

$$a_1x_1 + a_2x_2 + \cdots + a_px_p$$

where the a's are *given* numbers of the corpus, and the x's indeterminate numbers of the same corpus, the aggregate of these numbers is what is called an *ideal*. That which gives interest to this consideration is that the ideals obey in what concerns their divisibility the ordinary laws of arithmetic and that in particular every ideal is decomposable in one way and only one into ideal primes This is the *fundamental theorem of Dedekind*

On the other hand, we may consider numbers which satisfy an algebraic equation of which the coefficients belong to a domain D of rationality These numbers and those rationally expressible by means of them define a new domain of rationality D' more extended than D, and an algebraic corpus K' more extended than the corpus K which corresponds to D. We then may relate the corpus K', not to the ordinary rational numbers and to the corpus of the integers of ordinary arithmetic, but to the domain D and to the algebraic corpus K We then may speak of the *relative* degree of K' with reference to K, of the *relative norm* of an algebraic number of K' with reference to K, etc There will be corpora relatively quadratic obtained by the adjunction to the domain D' of a radical $\sqrt{\mu}$, μ being a number of the domain D, and corpora relatively abelian, obtained by the adjunction to D of the roots of an abelian equation This is a sort of generalization of the ideas of Dedekind, that Hilbert is doubtless not the first to have seen, but from which he has drawn an unexpected advantage.

We should also speak of galois corpora, whose generating equation is a galois equation. Any corpus is contained in a galois corpus, in the same way the corpus K of which we have just spoken is contained in the corpus K'; and this galois corpus is easily obtained by adjoining to the domain of rationality, not only one of the roots of the generating algebraic equation of K, but *all* its roots

Questions relative to any corpus are

thus made to depend upon the analogous problems for the galois corpora

After having shown how we may, by the discussion of a congruence, form all the ideals of given norm, Hilbert has sought a new proof of the fundamental theorem of Dedekind, he established it first for the galois corpora and then easily extended it to any corpus.

Thus Hilbert was led to study the general theory of galois corpora, and he introduced a host of new notions, defining a series of subcorpora, corresponding to different subgroups of the galois group of the generating equation, these subgroups are defined by certain relations they have with any ideal prime of the corpus, and the study of these subgroups opens for us glimpses new and interesting of the structure of the corpus.

Our author gave in 1896 a new proof of Kronecker's theorem according to which the roots of abelian equations can be expressed by the roots of unity This demonstration purely arithmetical puts in evidence the way of constructing all the abelian corpora of a given group and discriminant

But the works of Hilbert have had as their principal object the study of corpora relatively quadratic and relatively abelian

One of the essential points of the theory of numbers is Gauss's law of reciprocity in the subject of quadratic residues, we know with what predilection the great geometer returned to this question and how he multiplied demonstrations.

This law of reciprocity is capable of interesting generalizations when we pass from the domain of ordinary rational numbers to a domain of any rationality Hilbert has succeeded in realizing this generalization in the case where the corpus is imaginary and has an odd number of classes. He has introduced a symbol analogous to that of Legendre, and the law of reciprocity reached by him presents itself in a simple form, the product of a certain number of such symbols must equal 1

This generalization presents all the more interest since our author has succeeded in showing that there are genera corresponding to half of all the imaginable systems of characters, a result which should be likened to that of Gauss and which makes possible the extension to a domain of any rationality of this notion of the genus of quadratic forms which is the subject of one of the most attractive chapters of the "Disquisitiones Arithmeticæ"

To go farther, Hilbert is obliged to introduce a new notion and modify the definition of class

Two ideals belong to the same class in the old or broad sense if their ratio is any existing algebraic number, they belong to the same class in the new or narrow sense if their ratio is an existing algebraic number *which is positive as well as all its conjugates* The numbers of classes, whether understood in the broad sense or in the narrow sense, are evidently in intimate relation and our author explains what the nature of this relation is But this new definition allows Hilbert to express in simpler language the theorems he had in view These theorems stated in their most general form are, as Hilbert says, remarkably simple and of crystalline beauty, their complete proof appeared to our author as the final aim of his studies on algebraic corpora It is in this general form we shall state them

If k is any corpus, there is a group Kk which may be called its *class corpus*. Its relative degree is equal to the number of classes in the narrow sense. It is non-ramified, that is to say, no ideal prime of k is divisible by the square of an ideal prime of Kk, and it contains all the non-ramified

corpora relatively abelian with regard to k

Its relative group is isomorphic to the abelian group which defines the composition of the classes of ideals of k

The ideal primes of k, although prime in relation to k, are not in general prime in relation to Kk, they may, therefore, be broken into factors ideal primes with regard to Kk, the number of these factors and the power to which they are raised, in a word the mode of partition, depending solely upon the class to which the ideal considered belongs in the corpus k

Call "*ambige*" a number of Kk which is positive as well as all its conjugates, and which differs from these conjugates only by a factor which is a complex unity

Each ambige of Kk corresponds to an ideal of k and reciprocally This property is characteristic of the corpus Kk among all the corpora relatively abelian with regard to k

We see the bearing of these theorems and the light thrown on the notion of class, since the mutual relations of classes of ideals are reproduced as in a faithful picture by those of the algebraic integers of a corpus

In reality Hilbert has completely proved these theorems only in particular cases, but these particular cases are very numerous, exceedingly varied and broadly extended He is, besides, he says, convinced that his methods are applicable to the general case While sharing his conviction, we must make reservation, so long as this hope, legitimate as it may be, has not been actually realized

We have spoken above of the law of reciprocity relative to quadratic residues, we must add that Hilbert has given an analogous law for his residues of any power, at least for certain particular corpora

Summarizing, the introduction of ideals by Kummer and Dedekind was an important advance, it generalized and at the same time cleared up the classic results of Gauss on quadratic forms and their composition The works of Hilbert we have just analyzed constitute a new step in advance, not less important than the first

THEOREM OF WARING

Let us speak now of another entirely different arithmetical work It pertains to proving Waring's theorem according to which every integer can be broken into a sum of N nth powers, N depending only upon n, just as, for example, it can always be broken into a sum of four squares Needless to recall that this theorem up to the present had simply been stated

What above all deserves to fix the attention in Hilbert's proof is that it rests on a new way of introducing continuous variables into the theory of numbers

We start from an identity where a 25uple integral is equated to the mth power of the sum of five squares Breaking up the domain of integration into smaller domains so as to have a series of approximate values of the integral, as if it were a question of evaluating it by mechanical quadratures, and by the methods of passing to the limit familiar to our author, we reach another identity

$$(x_1^2 + \quad + x_5^2)^m = \Sigma r_h Y_h^{2m},$$

where the r_h's are rational positive numbers and the Y's linear functions of the x's with integral coefficients The coefficients r and those of the Y's, as also the number of these linear functions, depend only upon m.

Up to this point we have not gone out of algebra, if not in showing that the coefficients r and those of Y are rational. To get further our author establishes a series of lemmas whose statement is too complicated to be here reproduced and which

lead finally to the complete proof of the theorem We can not doubt that these considerations, which allow also the obtaining of arithmetical relations in making them come from identities where definite integrals figure, can some day, when we shall have grasped their meaning, be applied to problems much more extended than that of Waring

GEOMETRY

I come to Hilbert's works so very original on the foundations of geometry

There are in the history of this geometric philosophy three principal epochs, the first is that where thinkers at whose head we should cite Bolyai founded the non-euclidean geometry, the second is that in which Helmholtz and Lie showed the rôle in geometry of the notion of motion and of group; the third was inaugurated by Hilbert

The German author takes the logical point of view What are the axioms enunciated and those unconsciously assumed, what is their real logical content and what may be deduced from them by the simple application of the rules of logic and without new appeal to intuition? Finally, are they independent, or can we on the contrary, deduce them from one another? These are the questions to face

Hilbert commences, therefore, by establishing the complete list of assumptions, striving not to forget a single one That is not as easy as one might think, and Euclid himself uses some he does not state Geometric intuition is so familiar to us that we use intuitive verities, so to speak, without our perceiving them, hence to attain the aim Hilbert proposed to himself, the necessity of not according to intuition the least place

The savant professor divides the assumptions into five groups:

I Assumptions of Association (I shall translate by *projective assumptions* in place of seeking a literal translation, as, for example, *assumptions of connection*, which would not be satisfactory)

II Betweenness assumptions (assumptions of order)

III Congruence assumptions or metric assumptions

IV Euclid's postulate

V The Archimedes assumption

Among the projective assumptions we distinguished those of the plane and those of space, the first come from the well-known proposition *through two points passes one straight, and only one*

Going on to the second group, the order assumptions, here is the statement of the first two.

"If three points are on the same straight, they have a certain relation which we express by saying that one of the points, and only one, is between the other two If C is between A and B, if D is between A and C, D will also be between A and B, etc "

Here still we note that intuition is not brought in, we seek not to fathom the meaning of the word *between*, every relation satisfying the assumptions may be designated by this same word

The third group comprises the metric assumptions where we distinguish three subgroups, relative respectively to sects, to angles and to triangles

An important point here was not stressed (in the first German edition, though it appears in the French translation) To complete the list of assumptions it needs to be said that the sect AB is congruent to the inverse sect BA This assumption implies the symmetry of space and the equality of the angles at the base in an isosceles triangle Hilbert does not here treat this question, but he has

made it the subject of a memoir to which we shall return later

The fourth group contains only Euclid's postulate

The fifth group comprises two assumptions, the first and most important is that of Archimedes

Let there be any two points A and B on a straight d, let a be any sect, construction d, starting from the point A, and in the sense AB, a series of sects all equal to one another and equal to a

AA_1, A_1A_2, $A_{n-1}A_n$; we can always take n so great that the point B is on one of these sects

This is to say that, if we take any two sects l and L, we can always find a whole number n so great that by adding the sect l to itself n times, we obtain a total sect greater than L

The second is the assumption of completeness of which I shall explain the meaning further on

INDEPENDENCE OF THE ASSUMPTIONS

The list of assumptions once drawn up, it is necessary to see if it is free from contradictions We well know that it is, since geometry exists, and Hilbert first replied yes by constructing a geometry But strange to say, this geometry is not exactly ours, his space is not ours, or at least is only a part of it. In Hilbert's space are not all the points which are in ours, but only those that, starting from two given points, we can construct with ruler and compasses In this space, for example, there is no angle of 10°.

In his second edition Hilbert tried to fill out his list so as to obtain our geometry and no other, and so he introduced the assumption of completeness which he states as follows·

To the system of points, straights and planes it is impossible to adjoin another system of objects such that the complete system satisfies all the other assumptions.

It is evident then that this space of which I spoke, which does not contain all the points of our space, does not satisfy this new axiom, because we can adjoin to it those points of our space which it does not contain, without its ceasing to satisfy all the assumptions.

There is, therefore, an infinity of geometries which satisfy all the assumptions except the assumption of completeness, but only one, ours, which satisfies also this latter assumption

We then must ask if the assumptions are independent, that is to say, if we could sacrifice one of the five groups, retaining the other four, and nevertheless obtain a coherent geometry Thus it is, suppressing group IV (Euclid's postulate), we obtain Bolyai's non-euclidean geometry

We can equally suppress group III Hilbert has succeeded in retaining groups I, II, IV and V, as also the two subgroups of the metric assumptions of sects and angles, while rejecting the metric assumption of triangles, that is to say, the proposition III., 6

Non-archimedean Geometry.—But Hilbert's most original conception is that of non-archimedean geometry, where all the assumptions remain true save that of Archimedes For this it is needful first to make a ***system of non-archimedean numbers***, that is to say, a system of elements between which we can conceive relations of equality and inequality, and to which we can apply operations corresponding to arithmetical addition and multiplication, and this in a way to satisfy the following conditions:

1. The arithmetical rules of addition and of multiplication (commutativity, associativity, distributivity, etc., *arithmetical*

assumptions of combination) remain without change

2 The rules of the calculus and transformation of inequalities (arithmetical assumptions of ordering) likewise remain

3 The Archimedes assumption is not true

We may attain this result by choosing for elements series of the following form

$$A_0 t^m + A_1 t^{m-1} + A_2 t^{m-2} + \quad ,$$

where m is an integer positive or negative and where the coefficients A are real, and convening to apply to these series the ordinary rules of addition and of multiplication It is necessary then to define the conditions of inequality of these series so as to *arrange* our elements in a determined order We shall attain this by the following convention we will attribute to our series the sign of A_0 and we will say that a series is smaller than another when, if taken away from this, it gives a positive difference

It is clear that with this convention the rules of the calculus of inequalities hold good, but the Archimedes assumption is no longer true

Our common numbers come in as particular cases among these *non-archimedean numbers* The new numbers intercalate themselves, so to speak, in the series of our common numbers, in such a way that there is for example an infinity of new numbers less than a given common number A and greater than all the common numbers less than A

That settled, imagine a tri-dimensional space wherein the coordinates of a point are measured not by common numbers, but by non-archimedean numbers, but where the usual equations of the straight and of the plane hold good, as also the analytic expressions for angles and sects It is clear that in this space all the assumptions remain true, save that of Archimedes

On any straight between our common points would intercalate themselves new points Likewise there will be on this straight an infinity of new points to the right of all the common points In a word, our common space is only a part of non-archimedean space

We see what is the bearing of this invention and wherein it constitutes in the progress of our ideas a step almost as bold as that which Bolyai made us take, the geometry non-euclidean respected, so to speak, our qualitative conception of the geometric continuum while it overturned our ideas on the measure of this continuum The non-archimedean geometry destroys this conception, it dissects the continuum to introduce into it new elements

In this conception so audacious Hilbert had had a precursor In his foundations of geometry Veronese had had an analogous idea Chapter VI of his introduction is the development of a veritable non-archimedean arithmetic and geometry where the transfinite numbers of Cantor play a preponderant rôle Nevertheless, by the elegance and simplicity of his exposition, by the depth of his philosophic views, by the advantage he has derived from the fundamental idea, Hilbert has made the new geometry his own

Non-arguesian Geometry—The fundamental theorem of projective geometry is the theorem of Desargues

Two triangles are called *homologs* when, the straights joining each to each, the corresponding vertices are copunctal. Desargues proved that the intersection points of the corresponding sides of two homologous triangles are costraight, the dual is equally true

The theorem of Desargues can be established in two ways:

1 By using the projective assumptions of the plane and the metric assumptions of the plane

2 By using the projective assumptions of the plane and those of space

Therefore, the theorem could be discovered by a two-dimensional animal, to whom a third dimension would seem as inconceivable as to us a fourth, who consequently would not know the projective assumptions of space, but who would have seen displaced in the plane he inhabited rigid figures analogous to our solid bodies, and who consequently would know the metric assumptions Equally well the theorem could be discovered by a tri-dimensional animal who should know the projective assumptions of space, but who, having never seen solid bodies displaced, would not know the metric assumptions

But would it be possible to establish the theorem of Desargues without using either the projective assumptions of space or the metric assumptions, but only the projective assumptions of the plane? It was thought not, but we were not sure Hilbert has settled the question by constructing a *non-arguesian geometry,* which is of course a plane geometry

Non-pascalean Geometry—Hilbert does not stop there, he introduces still a new conception To understand it, we must return a moment to the domain of arithmetic We have above seen the notion of number enlarged by the introduction of *non-archimedean numbers* We need a classification of these new numbers, and to get it we first classify the assumptions of arithmetic into four groups

1 The laws of associativity and of commutativity of addition, the associative law for multiplication, the two laws of distributivity of multiplication, or, to summarize, all the rules of addition and of multiplication, save the law of the commutativity of multiplication

2 The assumptions of order, that is to say, the rules of the calculus of inequalities.

3 The law of commutativity of multiplication according to which we can invert the order of the factors without changing the product

4 The Archimedes assumption

The numbers which admit the first two groups are called *arguesian;* they may be *pascalean* or *non-pascalean,* according as they satisfy or do not satisfy the assumption of the third group, they will be *archimedean* or *non-archimedean,* according as they satisfy or do not the assumption of the fourth group We soon shall see the reason for these names

The ordinary numbers are at once arguesian, pascalean and archimedean We can prove the law of commutativity from the assumptions of the first two groups and the Archimedes assumption, so there are no numbers arguesian, archimedean and not pascalean

On the other hand, it is easy to make a system of numbers arguesian, non-pascalean and non-archimedean The elements of this system will be series of the form

$$S = T_0 s^n + T_1 s^{n-1} + \quad ,$$

where s is a symbol analogous to t, n an integer positive or negative, and T_0, T_1, numbers of the system T If therefore we replace the coefficients T_0, T_1, by the corresponding series in t, we shall have a series depending at the same time upon t and upon s We add these series S according to the ordinary rules, and likewise for the multiplication of these series, we shall admit the rules of distributivity and of associativity, but we shall hold that the law of commutativity is not true and that, on the contrary, $st = -ts$

It remains to *arrange* these series in an order so determined as to satisfy the assumptions of order. For that, we give to the series S the sign of the first coefficient

T_0; we shall say that a series is less than another, when if taken away from this, it gives a positive difference This, therefore, is always the same rule t is looked upon as very great with regard to any ordinary real number, and s is looked upon as very great with regard to any number of the system T

The law of commutativity not being true, these now are non-pascalean numbers

Before going farther I recall that Hamilton long ago introduced a system of complex numbers where the multiplication is not commutative, these are the *quaternions*, which the English so often use in mathematical physics But, for quaternions the assumptions of order are not true, what therefore is original in Hilbert's conception is that his new numbers satisfy the assumptions of order without satisfying the rule of commutativity

To return to geometry Admit the assumptions of [the first] three groups, that is to say, the projective assumptions of the plane and of space, the assumptions of order, and Euclid's postulate, the theorem of Desargues will follow from them since it is a consequence of the projective assumptions of space

We wish to establish our geometry *without using metric assumptions*, the word *length* therefore has now for us no meaning, we have no right to use the compasses, on the other hand, we may use the ruler, since we admit that we may pass a straight through two points, in virtue of one of the projective assumptions, equally we know how through a point to draw a parallel to a given straight, since we admit Euclid's postulate. Let us see what we can do with these resources

We can define the homothety (perspective similarity) of two figures, and through it proportion. We can also define equality in a certain measure

The two opposite sides of a parallelogram shall be equal *by definition*, thus we know how to recognize whether two sects are equal to one another, *provided they be parallel*

Thanks to these conventions, we now are prepared to compare the lengths of two sects, but *with the proviso that these sects be parallel*

The comparison as to length of two sects differing in direction has no meaning, and there would be needed, so to speak, a different unit of length for each direction It is unnecessary to add that the word *angle* has no meaning.

Sects will thus be expressed by numbers, but necessarily these will not be ordinary numbers All we can say is that if the theorem of Desargues is true, as we suppose, these numbers will belong to an *arguesian system*

Inversely, having given any system S of arguesian numbers, we can make a geometry such that the lengths of the sects of a straight may be exactly expressed by these numbers

The equation of the plane will be a linear equation as in the ordinary analytic geometry, but since in the system S multiplication will not be commutative, in general it is needful to make a distinction and to say that in each of the terms of this linear equation the coordinate will play the rôle of multiplicand, and the constant coefficient the rôle of multiplier

Thus to each system of arguesian numbers will correspond a new geometry satisfying the projective assumptions and those of order, the theorem of Desargues and Euclid's postulate What now is the geometric meaning of the arithmetical assumption of the third group, that is to say, of the rule of commutativity of multiplication?

The geometric translation of this rule is

Pascal's theorem; I mean the theorem about the hexagon inscribed in a conic, supposing that this conic reduces to two straights So Pascal's theorem will be true or false according as the system S is pascalean or non-pascalean, and since there are non-pascalean systems, *there likewise are non-pascalean geometrics* The theorem of Pascal can be deduced from the metric axioms, it therefore will be true if we suppose figures may be transformed not only by homothety and translation, as we have done, but also by rotation Pascal's theorem can likewise be deduced from the Archimedes axiom, since we have seen that every system of numbers arguesian and archimedean is at the same time pascalean, *every non-pascalean geometry is therefore at the same time non-archimedean*

The Sect-carrier—We cite still another conception of Hilbert's He studies the constructions we can make, not with ruler and compasses, but with ruler and a special instrument which he calls the *sect-carrier,* and which enables us to set off on a straight a sect equal to another sect taken on another straight The *sect-carrier* is not the equivalent of the compasses, this latter instrument enables us to construct the intersection of two circles, or of a circle and any straight, the *sect-carrier* will only give us the intersection of a circle and a straight *passing through the center of this circle.* Hilbert seeks therefore what are the constructions which are possible with these two instruments, and he reaches a very remarkable conclusion.

The constructions which can be achieved with ruler and compasses can likewise be made with the ruler and the *sect-carrier, provided these constructions are such that their result is always real.*

It is evident in fact that this condition is necessary, because a circle is always cut *in two real points* by a straight drawn through its center But it was hard to foresee that this condition would likewise be sufficient.

But this is not all, in all these constructions, as Kürschák first noticed, it is possible to replace the *sect-carrier* by the *unit-sect carrier,* an instrument which enables us to set off on any straight from any point of it, no longer any sect, but a sect equal to unity

An analogous question is treated in another article of Hilbert's *On the equality of the angles at the base of an isosceles triangle*

In the ordinary plane geometry, the plane is symmetric, which expresses itself in the equality of the angles at the base of the isosceles triangle

We should make this *symmetry of the plane* appear in the list of metric assumptions In all the geometrics more or less strange of which we have spoken hitherto, in those at least where we admit the metric assumptions, in the non-archimedean metric geometry, in the new geometries of Dehn, in those which are the subject of the memoir "On a New Foundation, etc," this symmetry of the plane is always supposed Is it a consequence of the other metric assumptions? Yes, as Hilbert shows, if we admit the Archimedes assumption No, in the contrary case There are non-archimedean geometries where all the metric assumptions are true with the exception of this of the symmetry of the plane

In this geometry it is not true that the angles at the base of an isosceles triangle are equal, it is not true that in a triangle one side is less than the sum of the other two, the theorem of Pythagoras about the square on the hypothenuse is not true. That is why this geometry is called *non-pythagorean.*

I come to an important memoir of Hil-

bert's which is entitled "Foundations of Geometry," which bears then the same title as his "Festschrift," but where he takes, however, a wholly different point of view In his "Festschrift," in fact, as we have seen by the preceding analysis, the relations of the notion of space and the notion of group resulting from the works of Lie are laid aside or relegated to an inferior place The general properties of groups do not appear in the list of fundamental assumptions Not so in the memoir of which we are to speak

As regards the ideas of Lie, the progress made is considerable Lie supposed his groups defined by analytic equations. Hilbert's hypotheses are far more general Without doubt this is still not entirely satisfactory, since though the *form* of the group is supposed any whatever, its *matter*, that is to say, the plane which undergoes the transformations, is still subjected to being a *number-manifold* in Lie's sense Nevertheless, this is a step in advance, and besides Hilbert analyzes better than any one before him the idea of *number-manifold* and gives outlines which may become the germ of an assumptional theory of analysis situs

It is impossible not to be struck by the contrast between the point of view here taken by Hilbert and that adopted in his "Festschrift" In this "Festschrift" the continuity assumptions took lowest rank and the great thing was to know what geometry became when they were put aside Here, on the contrary, continuity is the point of departure and Hilbert is above all anxious to see what we get from continuity alone, joined to the notion of group

It remains for us to speak of a memoir entitled "Surfaces of Constant Curvature."

We know that Beltrami has shown that there are in ordinary space surfaces which image the non-euclidean plane, these are the surfaces of constant negative curvature, we know what an impulse this discovery gave to the non-euclidean geometry But is it possible to represent the non-euclidean plane entire on a Beltrami surface without singular point? Hilbert has proved that it is not

As to the surfaces of constant positive curvature, to which Riemann's geometry corresponds, Hilbert proves that besides the sphere there is no other closed surface of this sort

(*To be concluded*)

SCIENTIFIC NOTES AND NEWS

DR DAVID STARR JORDAN has tendered to President Taft his resignation as international commissioner of fisheries, this position having been created three years ago under the treaty of April 11, 1908, with Great Britain Under the terms of the appointment, the work of the commissioner ceases on the completion of the series of fishery regulations of the boundary waters, and the technical investigations necessary for their completion This work being finished, the administration of the treaty passes to the Bureau of Fisheries

DR. WILLY KUKENTHAL, professor of zoology at Breslau, has been appointed exchange professor at Harvard University during the academic year of 1911–12

DR EDWARD MINER GALLAUDET has retired from the presidency of Gallaudet College, which he has held for fifty-four years

DR. OSCAR RIDDLE, of the University of Chicago, has returned from a year of study and travel in Europe He spent the past six months at the Zoological Station at Naples, whence he now returns to Chicago to take charge of the preparation for publication of the manuscripts left by the late Professor C. O Whitman He will also continue certain features of Professor Whitman's investigations

PROFESSOR GEORGE E SEVER has been elected president of the Columbia Chapter of

Sigma Xi as successor to Professor William H. Burr.

DR. F. E. CLEMENTS, professor of botany in the University of Minnesota, has been elected president of the Chapter of Sigma Xi in that university.

MR. W. C. COX, of the U. S. Forest Service, has been appointed to the newly created post of state forester of Minnesota.

AT a meeting of the Royal Dublin Society held on April 25, the Boyle medal of the society was presented to Professor John Joly, F.R.S., whose researches deal with physics, geology, mineralogy, botany and biological theory.

PROFESSOR A. C. SEWARD, F.R.S., has been elected president of a newly established Cambridge University Eugenics Society.

THE council of the Institution of Civil Engineers has made the following awards for papers read and discussed during the session 1910–11: Telford gold medals to Mr. W. J. Wilgus (New York) and Mr. J. Walker Smith (Edinburgh); a George Stephenson gold medal to Mr. Philip Dawson (London), Telford premiums to Messrs. G. W. Humphreys (London), H. K. G. Bamber (Greenhithe), A. E. Carey (London), William Dawson (Crewe) and C. S. R. Palmer (London), and the Trevithick premium to Mr. A. T. Blackall (Reading).

JOSIAH ROYCE, professor of the history of philosophy at Harvard, will be the university delegate at the celebration of the five hundredth anniversary of the University of St. Andrews.

THE American Philosophical Society has made the following appointments of delegates to represent it: At the jubilee of Professor Giovanni Copellini, to be held at Bologna on June 12 next, Professor Dott. Guglielmo Mengairni, of Rome. At the tenth International Congress of Geography to be held at Rome from October 15 to 22, 1911, Mr. Henry G. Bryant. At the thirtieth Congres National des Sociétés Françaises de Géographie to be held at Roubaix, France, from July 29 to August 5, 1911, Mr. Julius F. Sachse.

MR. C. W. BEEBE, curator of ornithology of the N. Y. Zoological Society, and Mrs. Beebe have returned from an extended expedition for the study and collection of pheasants in eastern countries.

IT is stated in *Nature* that Professor Hans Meyer will undertake in May his fourth journey in East Africa. Starting from Bukoba, on the west shore of Lake Victoria, he proposes to march to Lake Kiva and the Kirunga group of volcanoes, in order to study the relations of the volcanic phenomena to the tectonic structure of the western rift system at this point. From Kiva the expedition will travel by Lake Tanganyika and, if time permits, also to Lake Nyassa. Besides geological studies, the botany, zoology and ethnology of the region traversed will also be investigated.

ON the evening of April 28 Professor Edward L. Nichols, of Cornell University, delivered the annual address before the Iowa Academy of Science on the subject, "The Ends of the Spectrum." Professor Nichols visited the State University of Iowa on April 29, April 30 and May 1. He delivered lectures in the department of physics on recent work in luminescence, and one open to the public on "Daylight."

DR. JOHN M. CLARKE, state geologist and director of science in the New York State Education Department, gave an illustrated lecture before the departments of geology and biology of Colgate University on the evening of May 3. His subject was "The Magdalen Islands and the Bird Rocks."

ON April 13, Professor Heinrich Ries, professor of economic geology, Cornell University, lectured at the University of Alabama on the economic geology of the Canadian northwest.

MR. F. E. MATTHES, of the U. S. Geological Survey, is delivering a course of twelve illustrated lectures with accompanying laboratory work before the students of the University of Michigan, the subject of the lectures being, "Topographic Mapping." On May 3, by invitation of the Michigan Chapter of Sigma Xi, Mr. Matthes told in a popular lecture

"How the Map of the Grand Canyon was made" The maps of the Grand Canyon, Yosemite Valley and the new Glacier National Park have all been prepared by Mr Matthes, who is now engaged upon the map of the new Mt Ranier National Park

SAMUEL CALVIN, professor and head of the department of geology, State University of Iowa, and state geologist of Iowa, died at Iowa City on April 17 He was 71 years of age and had been connected with the University of Iowa for thirty-seven years

PROFESSOR J BOSSCHA, the Dutch physicist, died on April 15, aged seventy-nine years

DR J T THOMPSON, the author of valuable contributions to ophthalmology, died at Cardiff on April 28 He was a brother of Professor Sylvanus T Thompson

THE directors of the New York Public Library announce a gift of $375,000 by Mr Andrew Carnegie to be used for establishing and maintaining a library school

A BILL has been introduced into the legislature of New Jersey providing for the appointment of a state plant pathologist

DR CHARLES A. OLIVER, of Philadelphia, has bequeathed his property valued at $15,000 to the Wills Eye Hospital, the University of Pennsylvania and the College of Physicians of Philadelphia

THE Gray Herbarium, Harvard University, is to have new quarters for its library The structure will be a two-story addition to the present building and will extend to the west, taking the place of the old library wing, and covering part of the site recently occupied by the Asa Gray House, which was removed some weeks ago The addition will be of similar construction to the Kidder wing The library, which will be placed in the new building, is devoted to the classification of flowering plants and ferns It contains more than 20,000 volumes and pamphlets The gift which makes possible the erection of the new building amounts to $25,000, it comes from an anonymous friend of the university.

THE research committee of the National Geographic Society of Washington has made an appropriation of $5,000 for continuing the glacier studies of the two previous years in Alaska The work, beginning in June, 1911, will be done by Professor R S Tarr, of Cornell University, and Professor Lawrence Martin, of the University of Wisconsin, who have directed the National Geographic Society's Alaskan expeditions of 1909 and 1910 in the Yakutat Bay, Prince William Sound, and lower Copper River regions The 1911 expedition will study briefly a number of regions of glaciers not previously investigated by the National Geographic Society, although partially mapped by the Alaska Division of the U S Geological Survey, the Boundary Commissions, etc Work will be done on the present ice tongues and the results of glaciation in the mountains and plateaus of parts of the interior and some of the fiords of southeastern Alaska, the former having lighter rainfall and smaller ice tongues than the Yakutat Bay and Prince William Sound regions

THE Rome correspondent of the London *Times* calls attention to the fact that for some time past Herr Immanuel Friedlander, of Naples, has been working for the establishment in that city of an International Institute to carry on a continuous and systematic investigation of volcanic phenomena An observatory has existed on Vesuvius for many years, but from the insufficient means at its disposal no extended and systematic work has hitherto been possible Such an institute as Herr Friedlander contemplates will be provided with the necessary laboratories and instruments for the regular measurement of temperatures on Vesuvius, for the periodical collection and analysis of the gases, and for the registration and observation of local earthquakes of a volcanic character, not only during the eruptive phases of the volcano, but also throughout its periods of comparative calm It would form a training school for volcanologists, as well as give opportunity for other scientific persons to make observations Herr Friedlander's idea is not a new one An International Institute on Vesuvius was advocated some time ago by Professor Johnston Lavis, Mr Cool, a

Dutch engineer, and Professor Gaetano Platania have also supported the same idea In the opinion of Herr Friedländer, however, it would be better to place the institute in Naples itself, where there would be less danger to the costly laboratories and apparatus, and where the vicinity of the university and other scientific institutes would facilitate the work. After communicating his plan to the last International Geological Congress, held in Stockholm, and obtaining the approval of the congress Herr Friedlander set to work to canvass among the scientific societies of every nation for supporters He has now secured 62 eminent names, among them 25 Italians, 19 Germans and three Englishmen, Sir Archibald Geikie, the president of the Royal Society, Professor H L. Tempest Anderson, of York and Professor H L Bowman, of Oxford The Royal Academy of Naples and the Geological Committee of Italy have given their adherence to the scheme, some 60 of the most prominent scientific and political personages of Italy are forming a committee to promote it, and the Italian government will shortly decide as to what official support can be given also Herr Friedlander has himself generously subscribed £4,000 for the building fund, and another £4,000 to be spread over a term of ten years in ten annual payments The success of the scheme only depends now upon the amount of the subscriptions which will answer Herr Friedlander's appeal to the general public of every country As far as Italy is concerned the scheme has already obtained the full approval of the most important members of the scientific world

It is stated in the London *Times* that the regulations issued by the Belgian government for the prevention and cure of sleeping sickness in the Congo provide heavy penalties for neglect of the prescribed precautions. All employers of native labor must take measures to discover any cases of sleeping sickness among their staff and report them at once to the authorities. Those aiding others to neglect the treatment prescribed will be punished, as well as those who try to pass from infected to uninfected districts or *vice versa* It is noted that in order to combat the disease effectively it is all-important to discover those victims who have not yet reached the second stage—somnolence Such a measure would tend not only to decrease the mortality but also to limit the dissemination of the germs All suspects, therefore, are to be examined by the heads of trading posts or sent for inspection to the nearest doctor, who will carry out a thorough examination. Inspection posts are to be established on the main lines of communication in order to prevent suspects from carrying the disease into provinces which are as yet untouched. Natives from the surrounding countries will only be permitted to enter the unaffected regions of the Belgian colony after undergoing a searching medical examination at Ala or Jakoma

A Conference on Sleeping Sickness has been held at the British Foreign Office as a result of representations made of the danger of the spread of sleeping sickness in consequence of the construction of the Rhodesia-Katanga Railway, which runs from the north of Broken Hill to the Congo frontier and beyond The delegates to the conference were M Melot, representing the Belgian government, Dr van Campenhout, of the Colonial Office in Brussels, Dr Sheffield Neave, representing the Rhodesia-Katanga Railway, Dr Aylmer May, representing the Chartered Company, Dr Bagshawe, of the Sleeping Sickness Bureau, and representatives of the British Foreign and Colonial Offices

A committee for the study of the sea was appointed in 1909 by the Italian Society for Advancement of Science. *Nature* states that its work was so active and promising that the committee was converted by an act of parliament into an institution of the Italian kingdom. The Regio Comitato Talassografico Italiano is to be concerned with investigations of the Italian seas from the physical and chemical points of view as well as from the biological Great importance will be attached to practical questions concerning the navigation and the fisheries. Investigations of the

high atmosphere will also be made in connection with aviation. The president of the committee is the marine minister, and representatives of the chief institutes, academies and societies which take interest in sea investigations have been appointed as members In addition the committee has a scientific staff of its own; it receives a yearly grant from the Italian government of 60,000 lira, and the ships for the cruises are supplied by the Italian navy Four cruises in the Adriatic Sea have taken place already, the program of which was agreed upon with the delegates of the Austrian government, and a fifth cruise will soon start

THE report of the departmental committee appointed to report on the present condition and the future development of the collections comprised in the Science Museum at South Kensington and the Geological Museum in Jermyn-street, has been issued as a parliamentary white paper According to an abstract in the London *Times* the committee finds that the objects now exhibited are so much crowded that their due classification and utilization are impossible Buildings twice the size of those now used would be fully utilized by the existing collections without the addition of a single specimen The committee states that the physics section is hopelessly overcrowded In the motor car and aeronautical groups, both early construction and later developments will require further illustration The electrical engineering section requires to be increased by five or six times its present dimensions. In no section is there more urgent need of early action to secure for the museum examples of instruments and appliances that have marked the opening of a new era in invention and industry. A conference room, where scientific or technical societies might meet, a large lecture theatre, public demonstrations in the galleries, and the exhibition of temporary collections are also suggested. It is recommended that the geological survey offices and library and the Museum of Practical Geology, which are now cramped by the limitations of the building in Jermyn-street, should be grouped, as at present, in a single building, and it would be of great advantage to have that building erected as part of the general scheme at South Kensington If the collections in the Science Museum and in the Jermyn-street Museum were brought together they would provide the basis of a collection that would be complete as regards stratigraphical and economic geology. Such a collection in the new buildings, with the systematic collection of minerals and the paleontological collections in the British Museum (Natural History), would represent at a single center the whole field of geological science In most of the departments of science and its applications, the committee concludes, the museums contain much that is of great historical interest and value They are rich in specimens, instruments, machines and models selected and exhibited in such a manner as to repay systematic examination by the student. *In many sections, however, the* collections are now far below the standard which it is clear they ought to reach in these matters, and their proper organization is impossible in the existing accommodation A science museum in which all branches of physical science, pure and applied, and the scientific and economic work of the geological survey shall be adequately illustrated in close proximity to the other great museums at South Kensington would be of incalculable benefit alike to intellectual progress and to industrial development.

UNIVERSITY AND EDUCATIONAL NEWS

AT the recent session of the Alabama legislature the University of Alabama was given an additional appropriation of $300,000, to be expended during the next quadrennium for maintenance and new buildings.

Two gifts from Mr. Carnegie to the Carnegie Technical Schools were announced last week. On his recent visit to Pittsburgh he presented the schools with a valuable 725-acre tract of land that he had owned for some years at Garver's Ferry, twenty-five miles up the Allegheny River from Pittsburgh It will be converted at once into an experimental

station and engineering camp The other gift was a set of designs by Mr John Wynkoop, made in the École des Beaux Arts of Paris and awarded a medal

THE inauguration of Dr George Edgar Vincent as president of the University of Minnesota will take place October 18 or 19 next The date has been fixed by the fact that the American Association of State Universities will meet at Minnesota on these days

PROFESSOR JAMES R ANGELL, head of the department of psychology and dean of the Senior Colleges, has been chosen by the board of trustees of the University of Chicago to succeed George E Vincent, now president of the University of Minnesota, as dean of the faculties of arts, literature and science

MR GEORGE CHANDLER WHIPPLE, formerly in charge of the biological laboratory of the Boston water department and later of the sanitary work connected with the water supplies of New York City, since 1904 practising sanitary engineer, has been appointed professor of sanitary engineering in the Graduate School of Applied Science of Harvard University

DR ERNEST SACHS, of New York City, has been appointed associate in surgery at the Washington University Medical School, St Louis

IN Stanford University J A Koontz and E G McCann have been made instructors in electrical engineering

DR. H N ALCOCK, London, has been appointed to the chair of physiology in McGill University

DR EMIL ABDERHALDEN, professor of physiology in the Berlin veterinary school, has been called to Halle, to succeed Professor Bernstein, who retires from active service at the close of the present semester

DISCUSSION AND CORRESPONDENCE

THE COMPARATIVE VALUE OF METHODS FOR ESTIMATING FAME

IN a recent contribution upon "Historiometry as an Exact Science"[1] Dr F. A. Woods calls attention to what appears to be a failure of the "space method," as compared with the "adjective method," in solving the problem which I proposed in SCIENCE, October 7, 1910, viz, to determine by purely objective methods the comparative fame of Sophocles and Euripides This apparent failure might seem to support my statement that "historiometry so-called can never aspire to the name of an exact science" were it not for the fact that Dr Woods has not established the superiority of the adjective method in this particular instance For the purpose of illustrating the comparative value of methods for estimating fame I wish to examine the problem of the two Greek poets a little more closely

[1] SCIENCE, April 14, 1911.

Those who are familiar with Greek literature are well aware that Sophocles is superior to Euripides in majesty, grandeur and the various other qualities quoted by Dr Woods from Mr Jebb and the critics But there was one quality, not named by Dr Woods, in which Euripides excelled Sophocles and this one quality more than outweighs the sum of his deficiencies Mrs Browning alludes to this quality in her poem "Wine of Cyprus"

> Our Euripides the human,
>   With his droppings of warm tears,
> And his touches of things common
>   Till they rose to touch the spheres

The humanity of Euripides and "his touches of things common" have appealed to mankind far more than the majesty and ideal art of Sophocles Aristotle states that Sophocles represented the men and women of his dramas as they ought to be, but that Euripides represented them as they actually were It was because he was the first to portray upon the stage the motives and lessons of every-day life that philosophers, statesmen, poets and all other conditions of men have come to prefer the plays of Euripides to those of any other ancient writer.

In comparing Sophocles and Euripides it must be remembered that the latter inaugurated a new epoch and the changes which he

introduced into the drama found disfavor among the Athenians of the old conservative school It was for this reason that Sophocles won five times as many prizes as his younger rival, yet Sophocles himself came to see the significance of the new movement and in his later years began to imitate Euripides

As an influence in human history Sophocles almost sinks into insignificance when compared with Euripides Historians dwell at great length upon this point Curtius in speaking of "this importance of Euripides for the general history of the world" makes the following statement

The real classics, such as Pindar, Æschylus and Sophocles, are only to be thoroughly understood and appreciated by contemporaries, or by those who by study accommodate to them their whole way of thinking Euripides, on the other hand, by the very circumstance that he put an end to the severe style of earlier art, stepped forth from the narrower sphere of the merely popular, he asserted the purely human motives of feeling which find a response in every breast, hence his clearness and intelligibility, hence without presuming any special interest in the subjects derived from mythology or claiming a higher strain upon the intellectual powers, he satisfies the demands which men at all times and in all places make upon the drama He is at once interesting and entertaining, terrific and affecting, he offers a wealth of thoughts and reflections, which come home and are of importance to every one, and is a poet for every educated man who understands the language in which he writes For the same reason, too, he was able to affect the minds of the foremost among his contemporaries, such as Socrates, and the language of the Attic stage, as he developed it, became the standard for the drama For the same reason he also pointed out its path to plastic art, and showed it how it could do new and important things after the age of Phidias, and therefore, though in his lifetime he had been unable to prevail against the still acknowledged tradition of earlier art, he filled the world with his fame after his death, and found numerous followers among the poets, who made use of the Greek myths in order to obtain dramatic effects of universal human significance

This passage from Curtius is of great interest, for it not only illustrates the greater historical importance of Euripides, but it also shows that the ultimate significance of a man's work can not be measured by the prizes or honors which he may receive from contemporaries and that the forces which bring a man fame may go on with far greater intensity after his death than during his life time

In order to illustrate what the historian means when he says that Euripides "satisfies the demands which men at all times and at all places make upon the drama" a few examples may be given

Curtius states that the plays of Euripides accompanied the Athenian traveler by land and sea, so also in modern times when De Quincey started on his wanderings he took with him a pocket volume of Euripides Even Mr Roosevelt, when preparing for his African hunting trip, included in his famous "pigskin library" a copy of this same poet

Lucretius in discussing the indestructibility of matter translates from Euripides, "Nothing that exists can perish, but everything on decomposing takes on a different form", so also in modern times von Lippmann, in the introduction of his "Abhandlungen und Vortrage," hopes that the reader may imbibe the spirit of Euripides, who said, "Happy the man who has gained a knowledge of science"

The Greek poet Ion in his elegy to Euripides reminds him that his fame will endure as long as Homer's, and Dante in his "Divine Comedy" mentions among the shades of departed Greek poets Homer first and then Euripides Dante does not speak of Sophocles in his whole poem, and we can see from this how slight the influence of Sophocles was upon the thought of the middle ages

Seyffert in his "Kulturgeschichte der Griechen und Romer," when discussing the development of the drama, states that "the tragedians following Euripides made him their model and pattern without qualification and the Roman poets preferred paraphrasing his dramas to those of other tragedians" The Roman poet Ennius paraphrased the "Andromeda" and some twenty other tragedies of Euripides, so also we find in more modern times that Racine paraphrases the "Andromache" and other plays, Goethe paraphrases

the "Iphigenia," and Browning the "Alcestis." Racine, Goethe and Browning selected Euripides and not Sophocles for their special purposes, owing to the fact so well stated by Perrin that Euripides comes nearer to the modern heart than Sophocles or any other ancient poet. The best testimony upon this point, however, is that of Racine himself, who, writing in 1676 in the preface to his "Iphigenia," expresses his indebtedness to Euripides as follows

> As regards the portrayal of the passions I have endeavored to follow Euripides most exactly I confess that I owe to him a large number of the passages which have been most praised in my tragedy I have seen with pleasure, from the effect which my imitations of Homer and Euripides have produced upon our audiences, that good sense and judgment are the same in all ages The taste of Paris conforms to that of Athens My audiences have been moved by the same things which once moved to tears the most intelligent people of Greece and which made them say that among the poets Euripides was the most tragic of all, that is to say he knew how to excite to a marvellous degree the feelings of pity and fear, which are the true ends of tragedy

It is probable that Euripides through his "Iphigenia" alone has exerted a greater influence upon modern thought and feeling than Sophocles with all his plays combined Erasmus in 1524 translated the "Iphigenia" from Greek into Latin, Dolce gave an Italian rendering in 1560; Sibilet (1549), Rotrou (1640), Racine (1674), Leclerc and Coras (1675) gave different French imitations; many English versions were given in the eighteenth century, Goethe's "Iphigenia" was completed in 1787, Gluck's opera upon the "Iphigenia" was produced in 1774 and since his time over twenty other composers have set music to the same theme. The recent revival of interest in the "Iphigenia" through the choral dances of Miss Duncan is well shown by the increased demand for this and other plays of Euripides at book stores and libraries.

Many other examples might be given to illustrate the much greater historical importance of Euripides as compared with Sophocles, but enough has been produced to show that as regards the special purposes for which mankind at large read, consult, quote, paraphrase or otherwise make use of a poet Euripides has always been preferred to Sophocles. And the approximate ratio of this preference, according to the five objective methods employed in my previous paper, is over 2·1.

The failure of the adjective method to give a verdict agreeing with that so unmistakably expressed by history and by mankind at large is very evident The adjective method—by which is meant the ratio of the number of adjectives of praise against those of dispraise—neglects to give the specific value of the terms, human, sublime, artistic, etc, the summation of which is supposed to constitute fame. The ratio of mere numbers gives each qualifying adjective the same value, when perhaps the number of adjectives expressing humanity and feeling should be raised to the tenth power and those expressing majesty and art only to the second power

The mathematical formula for expressing fame (F) in the terms of its components a, b, c, etc, is not $F = a + b + c$, but $F = x\,a + y\,b + z\,c$, in which x, y, z, etc, are unknown and indeterminate functions. That historiometry can never become an exact science is evident from the fact that the values which men give these unknown historiometric functions are different in different ages, races and individuals The twentieth-century mind would lay more stress upon the scientific, the medieval mind upon the mystical; the Roman would lay more stress upon the legal, the Greek upon the beautiful; the clergyman would lay more stress upon the ideal, the business man upon the practical Until historiometry can develop a set of functions whose values shall be constant for all men in all ages it must remain among the most inexact of sciences.

Another objection to the adjective method is that fame is not a mere summation of eulogistic attributes. Napoleon, for example, heads Professor Cattell's well-known list[3] of 1,000 eminent men, in connection with which list its author makes the following statement:

[3] *Pop. Science Monthly*, February, 1903, p. 362.

"There is no doubt but that Napoleon is the most eminent man who has ever lived, yet it should give us pause to think that this Titan of Anarchy stands first in the thoughts of most men." In the passage just quoted we have one extremely eulogistic phrase "most eminent man" counterbalanced by another phrase of extreme disparagement "Titan of Anarchy." A similar array of favorable and unfavorable expressions can be found in any impartial biography of Napoleon It is this peculiar blending in one man of different extremes which has given Napoleon and many other men a great share of their celebrity; in such cases the ratio of the numbers of adjectives of praise against those of dispraise fails to give a true answer to the question, which man of a given group of men is the most eminent or historically most important

The space method and reference frequency methods of estimating fame are not open to the objections which have been raised against the adjective method The historian in discussing, for example, the respective influence of Euripides and Sophocles upon human affairs must necessarily devote more space and make more references to Euripides since his influence in this respect was much the greater, yet in doing this he need not necessarily employ any adjectives of direct praise or dispraise

The space method and reference frequency methods are also more free from the errors of personal equation than the adjective method In the sentence "Cæsar was ambitious" one person might regard ambitious as a term of praise and another of dispraise, yet these two persons would agree perfectly as to the number of lines in a biographical sketch of Cæsar or as to the number of times Cæsar was referred to in an index

In the selection of a method for estimating historical values it would seem then necessary first of all to dissociate the question of merit from that of fame, and the questions of excellence in particular directions from the broader questions of historical importance For estimating merit and excellence in particular qualities, which is perhaps the chief concern of the critic, the adjective method proposed by Dr. Woods may possess certain advantages But for estimating fame and historical importance, which is the chief concern of the "historiometrician," the adjective method would seem far inferior to the space and reference frequency methods.

As to the exactness of historiometry as a science, may we not say what Huxley once said of another science, the most exact of all. It "grinds your stuff of any degree of fineness, but nevertheless what you get out depends on what you put in"

C A. BROWNE

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DR. WOODS'S APPLICATION OF THE HISTOMETRIC METHOD

THE paper by Dr F A Woods, published in SCIENCE, April 14, giving the results of his metrical investigation of the biographies of eminent Americans is one of great interest. Both in method and results it opens fields of investigation of the highest sociological value He has proved the reliability of his figures by reaching approximately the same results, for the state of Massachusetts and the other thirteen original states, when using different sets of data, and while the variation in the results indicate what would be considered in physics as a large probable error, yet they are really small considering the method used and the number of observations

If the wide range shown thus by the different states in their production of eminent persons per thousand of their white population can not be explained by environment it is evident that the arguments for the dominance of hereditary ability will be strongly supported On the other hand, if it can be explained by a high coefficient of skew correlation with one or more series of quantities expressing any antecedent social condition it leaves just so much less for heredity to explain Thanks to the work of Galton and others, heredity is already mathematically expressed by the correlation of the characters of individuals in successive generations. And perhaps for that reason the tendency now is to exaggerate the

relative importance of heredity Dr Woods himself, judging from his article in *The Popular Science Monthly*, April, 1910, has taken an extreme view of the dominance of heredity over environment, and apparently he expects the present investigation to support that view The further publication of his results will therefore be awaited with special interest

The first series of quantities expressing environment in youth which is suggested for correlation with the percentage of eminence in maturity is educational The simplest measure of educational opportunity in each state is its expenditure per capita for school purposes We do not know the average per annum, but we do know, accurately for most of the states, the public expenditure forty years ago for the education of the present generation These data are given in Table 14 of the Report of the Commissioner of Education for the year 1910 For a first approximation we can assume that the ratio of per capita expense in the different states has been constant, and it is only with the ratio that we are concerned

Massachusetts stands highest with $3 73 per capita, which was more than twice the average of the whole country, and also more than twice the average of the thirteen states Dr Woods has tabulated. Connecticut is second with $2 74 New Hampshire stands near the average But it is well known that private educational institutions are relatively more important in New England than in any other part of the country, while Harvard and Yale colleges would substantially raise the preeminence of Massachusetts, Connecticut, and the whole group, in the total per capita expense table, and so give them the places they have in Dr Woods's table

Virginia, which Dr. Woods found to be generally below the average in the table of eminence, is credited with only 47 cents in the expense table But including West Virginia, which was not separated until 1863, the average was 86 cents

South Carolina, which Dr Woods found to be slightly above the average for the white population, is credited with only 38 cents per capita of the whole population But that state had the highest percentage of colored population (60 per cent in 1870), while forty years ago most of the school money was spent on the white schools, and in ante-bellum days of course it was all for the white population. This would raise the per capita expense to 95 cents, and give it good rank among the southern states, but still below the average of the thirteen states Why this state should stand above the average in Dr Woods's table remains to be explained It shows, as we should expect, that schools do not supply all of a child's environment, and other correlations must be sought—the ratio of whose coefficients ought to be significant of their relative importance in making eminent persons

North Carolina, which Dr Woods found "has always had the worst record" for the production of eminence, the percentage being about one-fourth the average, is credited with only 16 cents per capita for education—this being the lowest for the thirteen states, and also for the whole country—being in fact about one tenth the average But applying the same total expenditure to the white population the per capita expense would be 25 cents —about one sixth the average

The average number of days of public schooling given to each inhabitant between the ages of five and eighteen years, in the school year 1870–71, in the New England and middle states was 70 2 days, and in the southern Atlantic states only 18 1 days The per capita expense therefor was $2 38 and 63 cents, respectively

We seem to be near the time when the cost of encyclopedic eminence can be stated in dollars without making any reflection on the compilers of those works.

Further, if we can approximate the expense of higher as well as elementary education in each state, we can easily, by the method of least squares, determine the ratio between them which is most favorable for the production of eminent persons

It appears that Dr Woods has directly opened the way to the mathematical determination of the relative importance of hered-

ity and environment At least we may expect a flood of new light on the subject from historical investigations, and if the conclusion is different from what the author of the method anticipated it will not at all detract from the credit due him for its development

GEO H JOHNSON

BROOKLYN, N Y

METALS ON METALS, WET

TO THE EDITOR OF SCIENCE A year or two ago I repeated to a class in elementary physics the statement, familiar to generations of engineers on the authority of General Morin, supported by the approval of Rankine, that the coefficient of friction of *metals on metals, wet*, is considerably greater than that of *metals on metals, dry*

Thereupon a thoughtful youth in the class asked me why, if this were the case, it was customary to put sand on wet car-rails to prevent the slipping of the driving-wheels Taken aback by this unexpected scepticism, I begged for time to find the right answer to the disturbing question and set to work experimentally on the problem The student reported after a time that trackmen had told him the water they had trouble with was usually slimy, which seemed to be a fairly satisfactory explanation of the puzzle, but meanwhile my experiments had shown some interesting facts, which I will here set forth

Using a disk of brass, about 7 5 cm in diameter and about 0 6 cm thick, on a flat brass plate, I found.

1 That, when there was no load on the disk, a few small drops of water placed between it and the plate multiplied by a factor which might be as great as 3 the friction between the two.

2 That, when the disk was heavily loaded, the presence of the few small drops of water between it and the plate made little, if any, relative difference in the friction between the two.

3 That when plenty of water was used, so that it covered the whole space beneath the disk and extended somewhat beyond the edge, the disk without load was drawn along the plate quite as easily, apparently, as when both were dry

From these facts I came to the conclusion that the increase of friction observed in case 1 was not due to an increase in the *coefficient* of friction caused by the water, but merely to the increase of pressure between the disk and the plate, caused by the suction of the capillary perimeters of the water-spots between them When there is much water its perimeter is outside the edge of the disk, is wide, or thick, and has little effect

Some little search in books dealing with the subject of friction has failed to show there any recognition of this possible explanation, and refutation, of the Morin-Rankine statement of the large value of the coefficient for *metals on metals, wet*, but I should hardly have written you about the matter if I had not recently found this statement repeated in the "Smithsonian Physical Tables" published in 1903 I hope the new edition of these tables will not quote Rankine on this particular without further evidence

EDWIN H HALL

CAMBRIDGE, MASS,
April 29, 1911

SCIENTIFIC BOOKS

The Stability of Truth By DAVID STARR JORDAN New York, Henry Holt & Co 1911 Pp 180

"This little book," says the author, "represents the substance of a course of lectures delivered on the John Calvin McNair foundation in the University of North Carolina, January, 1910"

The chapter headings are· Reality and Science, Reality and the Conduct of Life, Reality and Monoism, Reality and Illusion, Reality and Education, Reality and Tradition.

Evidently something has happened in philosophy, in science or in both when a scientist of the first class, not to say the author of this volume in particular, puts out a book with the good old philosophical term, "Reality" at the head of every chapter Doubtless in the minds of most scientists there will be little question about where "something has happened"

They will say that philosophy has at last discovered that neither its problems nor its methods are so fundamentally different from those of science as was once supposed, that there is now a great philosophical movement, with an evolutionary logic—the conception of the working hypothesis—as its avowed method, and that it is therefore now possible for a scientist to stroll into the field of philosophy and set to work with his own tools. And indeed the spirit of this philosophical movement variously known as "pragmatism," "evolutionism" and "experimentalism," is certainly very different from the Hegelian idealism, which found the difference between philosophy and science to consist in the fact that the doctrines of the former are "necessary," while those of science are merely "hypothetical."

Still, in such a *rapprochement* as is taking place between philosophy and science it would be strange if all the change were on one side. For one thing, it seems obvious that the surrender of absolutistic methods by philosophy means added responsibilities for scientific method. Under the old régime science, even while renouncing and denouncing philosophy and all its works, found comfort in turning over to philosophy certain ethical and social questions which it found difficult to handle or which interfered with the pursuit of "purely scientific truth."

Much of the doctrine of this book (whose title, by the way, means that the only truth that is stable is that truth is not stable) is to the effect that if important human interests formerly turned over to transcendental methods are now thrown back upon scientific method, this method must be human enough to take care of them. And this means that scientific method and interest can not be purely intellectualistic. The author says:

> The purpose of this book is to set forth the doctrine that the final test of truth is found in trusting our lives to it. . . The primal impulse, as well as the final purpose of science is the conduct of life. . . . Pure science can not be separated from applied science. . . . Knowledge is power; power is evidence that our belief is knowledge.

These and other similar statements on almost any page warrant the reader in saying that the book points at the hyper-intellectualism of science no less than at that of philosophy.

From the specific doctrines of the book the following points have been specially noted: (1) The recognition, rather unusual in a natural scientist, of the social character of consciousness and the self. "I think, therefore I am, gives place to we think, therefore we are." (2) Mr. Balfour's philosophic doubt is well hit off as "a process by which men question the only things they know to be true in order to prove the reality of things they know not to be true." This applies to all "transcendental doubt." (3) The "recrudescence of superstition," which accompanies an age of science, "is made possible by the fact that the traditions of science are so diffused in the community at large that fools find it safe to defy them." (4) Superstition and dogmatism are shown to be identical in so far as both ignore the process of experimentation. (5) The chapter on Reality and Monism, which is one of the best, puts two questions to Haeckel's monism. Is it a genuine scientific hypothesis, that is, one capable of verification? Is it of any ethical significance in the conduct of life? The author finds for the negative in both cases. (6) In the last chapter on Reality and Tradition, the "warfare between science and theology" is found to be quite as much a warfare between old and new science and to exist in the individual mind of the scientist and theologian alike.

In view of the general insistence upon the organic connection between science and the conduct of life, some readers may find difficulty with certain passages on "Belief," in which belief is justified as a "philosophical" category by "its effect on the conduct of life," even though it "is not reducible to terms of human experience" (pp. 42, 44). But "as men of science," we can not accept any hypothetic "articles of faith" not resting on "scientific induction." "I ought not to say I believe when I can not say I know" (p.

86). Some may take this to mean that "the conduct of life" may still be considered (*e g*, ethically or "philosophically") apart from science, and, conversely, that science may still have an aspect (*e g*, the pursuit of truth) that is independent of the conduct of life

The author's captivating style is too well known to call for comment The publishers have given the book a very attractive form

A W MOORE

Allen's Commercial Organic Analysis Volume IV, Resins, India-rubber, Gutta-percha and Essential Oils Philadelphia, P. Blakiston's Son and Co Pp viii + 466. $5.00 net

The subjects covered in this volume are Resins, by M Bennett Blackler, India-rubber, Rubber Substitutes and Gutta-Percha, by E W. Lewis, Hydrocarbons of Essential Oils, by T. Martin Lowry, Ketones of Essential Oils, by T. Martin Lowry, Volatile or Essential Oils, by Ernest C Parry, Special Characters of Essential Oils, by Henry Leffmann and Charles H LaWall.

As with the previous volumes of the series, the book contains a very large amount of detailed information which is very valuable for any one who has occasion to work with the great number of organic compounds which are used in industry The preparation of the successive chapters by chemists who have expert knowledge of the subjects of which they write insures accuracy and a wealth of information which it would be impossible to secure in any other way

W A NOYES

SCIENTIFIC JOURNALS AND ARTICLES

THE April number (volume 12, number 2) of the *Transactions of the American Mathematical Society* contains the following papers:

Anna J Pell "Biorthogonal systems of functions."

Anna J. Pell: "Applications of biorthogonal systems of functions to the theory of integral equations."

C. N. Moore. "On the uniform convergence of the developments in Bessel functions."

H H Mitchell "Determination of the ordinary and modular ternary linear groups."

G D Birkhoff "General theory of linear difference equations"

THE April number (volume 17, number 7) of the *Bulletin of the American Mathematical Society* contains "Groups generated by two operators satisfying two conditions," by G A Miller, "Fundamental regions for cyclical groups of linear fractional transformations on two complex variables," by J W. Young, "On the relative discriminant of a certain Kummer field," by Jacob Westlund, "Note on reciprocal figures in space," by Peter Field, "Mathematical physics for engineers," review of Gans' Einfuhrung in die Theorie des Magnetismus, Schaefer's Einfuhrung in die Maxwellsche Theorie, and Jahnke and Emde's Funktionentafeln und Curven, by E. B Wilson, "Shorter Notices" Huntington's Fundamental Laws of Addition and Multiplication in Elementary Algebra, by N J. Lennes, Borel's Théorie de la Croissance, by R D Carmichael, Tannery's Elemente der Mathematik, by J B Shaw, Weitzenbock's Komplex-Symbolik, by C L E Moore, Staude's Analytische Geometrie des Punktepaares, des Kegelschnittes und der Flache zweiter Ordnung, by D D Leib; Festschrift zur Feier des 100 Geburtstages Edouard Kummers, by L E. Dickson, Thiele's Interpolationsrechnung, by H L Rietz, Slaught and Lennes's Plane Geometry, by F W. Owens; Breckenridge, Mersereau and Moore's Shop Problems in Mathematics and Lester's Integrals of Mechanics, by C F. Craig, Annuaire du Bureau des Longitudes, by E W Brown; De Montessus' Leçons élémentaires sur le Calcul des Probabilités, by E. B Wilson, "Notes"; "New Publications."

The May number of the *Bulletin* contains: Report of the February meeting of the society, by F. N. Cole, "On the classification of crystals," by Paul Saurel; "Horner's method of approximation anticipated by Ruffini," by Florian Cajori, Review of the New Haven Colloquium Lectures, by G. D. Birkhoff; "Shorter Notices": Bauer's Vorlesungen

über Algebra, by Arnold Dresden, Richard and Petit's Théorie mathématique des Assurances, by E. B. Wilson, "Notes", "New Publications."

THE QUIZ DEMONSTRATION SYSTEM OF TEACHING QUALITATIVE ANALYSIS

It is time that we are awakening to the fact, that in the line of elementary laboratory work there is altogether too much poor impartation of knowledge. This is particularly the case as regards general chemistry and qualitative analysis, especially when considered from the standpoint of those who expect to carry on their life work in the field of engineering and industrial chemistry.

Qualitative analysis is especially subject to error. Who would think of trusting to a civil engineer, ignorant of the strength of the material employed, the construction of a bridge? Or one's child to a doctor, if cognizant of the fact that he did not know the properties of the drug he was administering? Is it not of as great import to a chemist that he understand the properties of the chemical elements, the material he is using in his daily work?

This being true, why is it that the laboratory instruction is, in many cases, left to assistants paid the munificent sum of from $200 to $500 per year, with, consequently, very indifferent instruction? If they are the best the institution can afford, the fault can be remedied, in part, by the man in charge giving to his assistants all the instruction within his power.

Detail laboratory instruction is the hardest of work, if rightly given, as difficult as any quiz or demonstration, for what is it, if properly conducted, but one continual individual quiz and demonstration of from two to three hours' duration? It is common to consider from two to three laboratory hours as equivalent to one lecture or quiz hour. This is a mistake, at least as far as the instructor is concerned, for it is not a greater impossibility for a man to lecture or quiz for half a day at a time, day in and day out, than for him to give the best that is in him to a laboratory class extending over a like period. I hear some one reply that it takes more time to prepare for a lecture or quiz than for a laboratory period. Granted, when the laboratory work is conducted as is most customary. But when the instructor keeps abreast of the times, makes a *thorough* test of the new methods, keeps track of and endeavors to overcome the difficulties of the ordinary class in qualitative analysis, he will devote much more time to the preparation of his work than a language teacher, for instance, who, year after year, employs the same text in class work. You see I am not making the statement, "He does this," but that he should. This is, of course, not possible when the hours of labor are too many to allow for it the requisite time. They should be shortened. There should be a certain amount of time spent by the instructor in his laboratory "doing things." A German teacher must know how to read the language. To teach laboratory work correctly a man must be able to do the work well himself.

Inasmuch as I am desirous of suggestions and criticisms from my fellow instructors, an underlying, selfish motive prompts me to present the scheme for laboratory instruction employed by me. It is one which I have successfully made use of during the past three years and I feel it a step in advance of the methods heretofore used by me, and of those which I have seen employed elsewhere.

Chemical theory is based on facts obtained in the laboratory. It is then true, that for a thorough comprehension of the theory it is necessary that the student be conversant with the facts before he can understand the application. I proceed, therefore, with this in view, as my main objective point.

As an essential, the instructor must see every test made by the student. That this may be accomplished the too often "drifting" about the laboratory by the instructor must be done away with. There must be system. There must be known, to some one in charge, what is going on in every part of the laboratory. Yet in this system, two things must be guarded against in the student. First, lack of independence. Second, useless waste of time.

with consequent disheartenment and lack of interest in the work

In considering Group I, consisting of lead, silver and mercury, the student is given a typewritten sheet of reactions to perform These are carefully selected to bring out the properties of the elements, especially those which are of most importance in qualitative and quantitative analysis At the completion of the experiments on silver or on silver and lead, in place of throwing out the contents of his test-tubes, the student takes them to the instructor in charge, and the latter, a man of experience, after examining the work carefully, gives him a thorough quiz on it If this work, as well as the student's knowledge of the reactions, etc, is satisfactory, the instructor places his O K upon the sheet If neither the quiz has been passed in a creditable manner nor the student been able to obtain the correct reactions, the contents of the test-tubes are thrown out and the work repeated. After a second trial, if the experiment is still unsuccessful, the instructor should demonstrate it By this means the student is taught independence, there is created in him ability to do things for himself, the instructor is enabled to "keep tab" on the work accomplished, knows if the student has obtained the correct result and yet does not allow him to spend an undue amount of time on something which it is clear he does not understand

This quiz demonstration system is varied to suit the needs of the individual These, the instructor, coming in personal contact with each student as he does, soon comes to know

Before the younger men of the force are allowed to quiz, they should observe the methods of the instructor in charge and then be subject to his direct supervision from time to time, when they themselves are quizzing Thus, in as far as is possible, the policy of the laboratory is uniform and at the same time consistent with the individuality of the persons in question

Upon completion of the preliminary work upon a particular group, the separation of the included elements is studied in a similar manner When the results of this work have received the O K of the instructor the student is given a number of simple unknowns on this group I find that by requiring that he do two of these for every one upon which he makes a mistake, his mistakes become fewer in number and his confidence in his ability thereby increases In taking up the second and following groups, the separations and preliminary work are treated similarly to group one, except that when time is available one of the unknowns is made to contain one or more of the elements of the preceding group In this way the separation of the various groups may be quizzed over as in the separation of each group

The groups and acids take up somewhat over one half the time allotted to the course Then come the general unknowns, where the work of the student is expected to be carried on independently Several simple mixtures are first given, that the student may better connect the group separations In these both the metal and acid are identified Then follow a number of commercial products, consisting of minerals, slags, alloys, etc, the selection being governed, to a certain extent, by the particular field which the student is likely to enter In this district mining interests are of most importance, hence, ores, minerals, slags, etc, make up this portion of the course

Individual quizzing on this part of the work is not as frequent as before, but when reporting an unknown, the student is quizzed on reactions, method of separation, identification, etc Here class-room quizzing is of more value and can be advantageously used to supplement part of the work with the individual, for, provided he be properly trained in the power of observation, a great amount of knowledge can be gleaned by the student from the mistakes of others, brought to his notice by this group questioning.

At this point too much stress can not be laid upon the exceptions to the general rules and the reason for each step taken in the separation. Herein is differentiated the training of the professional from the routine chemist. I find, also, at this point in the training, of the

utmost importance, and yet one of the greatest difficulties encountered, is the mastery of the proper method of disintegration, especially of the insoluble substances and those which are likely to lose part of their content by volatilization. If a proper solution of the unknown is obtained, the analysis is comparatively easy, whereas, if not obtained, incorrect results are sure to follow. Alloys and metallurgical products containing relatively small amounts of some one substance also require special attention.

Objections have been raised to the use of technical products for unknowns, claiming that they do not give the proper amount of training. This is apt to be true where unknowns of a commercial nature are taken just as they come to hand without special effort on the part of the instructor. It is certainly not the case if care is taken in obtaining what is necessary to suit the problem in question, for there are certainly sufficient varieties of commercial products to cover the field. Aside from giving the students a training not to be had in the use of laboratory prepared unknowns, his interest is much more easily aroused and held when he can see something "practical" in what he is doing.

I have found that where lectures are combined not alone with class-room quizzing but as well with this demonstration method the student is made to think and gets a grasp on the subject well worth the time spent in its acquisition.

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HUMUS IN DRY-LAND FARMING

It has been the consensus of agricultural opinion and experience, both in this country and in Europe, that the production of wheat on the same land year after year results in steadily decreasing yields. Chemical investigations in several instances have shown this decrease in yield to be accompanied by a correlated decrease in the supply of humus and of nitrogen in the soil. Under the title of "The Nitrogen and Humus Problem in Dry-Land Farming," Mr. Robert Stewart, chemist of the Utah State Experiment Station, has recently published the results of some investigations with special reference to the effect of continued wheat growing on the non-irrigated lands of the Cache Valley in Utah.[1]

Mr. Stewart's investigations in the Cache Valley indicate that the continuous production of wheat in that section has not resulted in a reduction of either the humus or the nitrogen supply of the soil, at least during the thirty years or more that wheat has been so grown there. He finds, indeed, that in something over twenty cases where comparisons were possible between virgin soil and soil that had been cropped to wheat for several years there has been a slight increase, both in the total nitrogen and the humus in the surface foot. In the second foot of soil on these two sets of fields he finds a decrease of the total nitrogen on the cropped land, but a marked increase in the humus. His summary of results shows that on the wheat land there has been a 10 per cent. increase in the humus supply of the surface foot and a 25 per cent. increase in the second foot.

Mr. Stewart wisely avoids any generalizations upon the limited data he presents in this publication. But it is unfortunate that he does not give more consideration to the agricultural conditions and farming methods that prevail in the region of which he writes. Unless the reader of Mr. Stewart's bulletin is familiar with conditions in the Cache Valley, the results presented are likely to seem either pointless or irreconcilable with the results of similar investigations elsewhere. To one who knows those conditions, the brief statement that "Some of the farms of this district have been under cultivation for forty-five years, and apparently yield as good crops as they ever did" may seem to be a good and sufficient epitome of the situation; but if one does not know the region, this sentence hardly seems adequate.

It is true that accurate data as to the farm yields for past years are difficult to obtain and

[1] Utah Agricultural College Experiment Station Bulletin, No. 109, August, 1910.

are unsatisfactory to use, because of the uncertain factor of variable climatic conditions from year to year; but some comparisons might have been made between the yields obtained during recent years from land that has long grown wheat and the yields on virgin or nearly new fields on similar soils. Or, lacking such data, it would have been helpful to the reader had there been given some statement as to the present wheat yielding capacity of the fields from which the samples were obtained.

Unless it is shown definitely that the maintenance of the nitrogen and humus content of these Cache Valley soils is correlated with the maintenance of their wheat yielding capacity, these investigations lose much of their possible value.

As to the matter of the farming methods for wheat production on this Cache Valley land, it is the general practise to harvest the grain with a header or with a combined harvester and thresher, either of which implements leaves on the land the major portion of the grain straw, which is subsequently plowed under.[3] Mr. Stewart makes incidental reference to this feature of the agricultural practise in the Cache Valley, but he does not make it clear that in this respect that practise is essentially different from what it is in the dry-land wheat regions of the Great Plains and eastward, where it is the custom to harvest the grain with a binder and remove the larger part of the straw. This omission seems particularly unfortunate, in view of the general, and possibly misleading, inferences that may be drawn from Mr. Stewart's otherwise valuable contribution to knowledge. If, as it seems reasonable to believe, the true explanation of the observed humus maintenance lies in the practise of plowing under each year the large amount of wheat straw, it becomes apparent that similar results are not to be expected where a similar practise is not followed.

C. S. SCOFIELD

U. S. DEPARTMENT OF AGRICULTURE,
January 14, 1911

[3] See Bulletin No. 103, Bureau of Plant Industry, U. S. Department of Agriculture, pp. 31–35, issued May 31, 1907.

SPECIAL ARTICLES

SOME EXPERIMENTS ON THE PRODUCTION OF MUTANTS IN DROSOPHILA

MACDOUGALL has reported the successful production of mutations by treating the ovaries of certain plants chemically or osmotically. As long as the full account of his results is not available, it is not easy to judge to what extent it is possible to produce mutations at desire with his method. Tower has apparently succeeded in producing in various species of *Leptinotarsa* certain color mutations at desire by submitting the beetles, during the period of the growth of the eggs, to different degrees of temperature and moisture from those in which they usually live. Gager mentions that by treating the pollen or ovaries of *Œnothera* with radium, some of the new plants were entirely different from the mother plant. Morgan has published the statement that a number of the interesting mutations of *Drosophila*, which he has recently described, came from a culture which had been treated with radium.

The following experiments were undertaken for the purpose of forming a conception concerning the degree of certainty with which mutations can be produced experimentally. We tried the effects of a constant and comparatively high temperature, of radium and of Röntgen rays. The stock of *Drosophila* which we used in these experiments was given us kindly by Dr. Lutz, to whom we wish to express our thanks.

1. *Effects of High Temperature.*—Several culture dishes with *Drosophila* were put into a thermostat, the temperature of which remained constant within 1° around 30.5° C. We found that at higher temperatures we lost a large number of cultures. In the fifth generation of flies, kept in the thermostat, on February 16, a number of dark flies appeared. They were mated with normal ones of the same culture. Some of these cultures were kept in the thermostat and others were brought into room temperature, to see whether at a lower temperature they would continue to breed true. This has now been the case for five

generations Darkness is recessive to the normal yellow and is not sex limited Our dark mutation is possibly identical with Morgan's "melanotic" mutant

On the seventh of March we began to repeat this experiment with the necessary control at room temperature On April 10, we found in the first filial generation of the control culture kept at normal temperature a dark specimen None of eleven new cultures kept in the thermostat have thus far given rise to a dark or any other type of mutant Since then dark individuals were found in another control culture

From these experiments we must draw the conclusion that a constant temperature of 30 5° does not necessarily produce mutations in *Drosophila,* and second, that a dark form of *Drosophila* may arise "spontaneously," that means by forces at present unknown

2. *Experiments with Radium*—A very large number of experiments with radium were undertaken, because it happened that the first culture which we treated with radium chanced to give us mutants We succeeded in producing short-winged specimens in two different cultures by treating them with radium, while thus far we have not yet observed this mutation in cultures not treated with radium The manner of appearance of this short-winged mutation was in both cases the same In the second filial generation of the flies treated with radium, one or more short-winged males appeared The various forms of mating were tried and yielded the result that the short-winged condition is a sex-limited character The wild normal males were found to be heterozygous in regard to short wingedness Thus our short-winged mutant behaved like, and is probably identical with the "miniature"-winged mutant discovered by Morgan. We have now bred the short-winged males and females for five generations and find that they remain constant

We expected that we might succeed in producing short-winged mutants at desire, but in this we failed Although we treated more than two hundred different cultures with radium we only observed the appearance of the short-winged mutation in the two cultures, although we repeated the conditions of our successful experiments quite frequently In both successful cases we submitted the animals only for one or two hours to the action of radium In one of the two cases the newly-hatched imago alone, males and females were treated for two hours with a weak radium preparation (10,000 units) which was coated with collodium It is possible that the alpha rays may have affected the animals In the second successful case a strong radium bromide preparation (over 1,000,000 units) in a glass tube was applied for one hour to a mixture of imago, eggs and young larvæ

In five different cultures of flies treated with radium the dark mutation appeared, but, while the short-winged mutants appeared in both cases in the second filial generation, there was no regularity in regard to the appearance of the dark mutants

In one culture treated with radium a white-eyed female appeared in the first filial generation, it is possible that the existence of a white-eyed male in a previous generation may have escaped our notice In two radium cultures we observed the pink-eyed mutants, but this was also found in cultures not treated with radium

3 *Experiments with Rontgen Rays* have given us thus far no mutants

Our results can be summarized as follows:

1 A large number of cultures of *Drosophila* were treated with high and constant temperature, with radium, and with Rontgen rays Four types of mutations were observed, a dark form (which was the most common), a pink-eyed, white-eyed and short-winged form.

2 In the control cultures, which had not been treated, the dark and the pink-eyed mutations were also observed. As far as the white-eyed mutation is concerned, it is probable that it originated before the treatment of the culture with radium

3 The short-winged mutants have appeared thus far only in the cultures treated with radium, namely in two cultures out of several hundred We did not succeed in producing the short-winged mutation at desire by treat-

ing the cultures with radium

We wish to express our thanks to Mr Berlinicke, of the firm of Hugo Lieber & Co, who was kind enough to loan us the radium used in these experiments, and to Mr Bagg, who assisted us in our observations

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AN EXPERIMENT IN DOUBLE MATING

IN my "Inheritance in Silkworms, I," (1908)[1] I called attention (pp 37–39) to the beginnings of an experiment in double mating Only the F_1 generations following a few matings had been obtained at that time, but they gave such promise of interest that I determined to continue the experiment and to widen it I have now in hand the notes on 85 silkworm broods belonging to this double mating experiment series of 1910 Some of these broods are the F_4 generation from the original 1907 double matings, while others are F_3 or F_2 generations from the original 1908 or 1909 double matings Taken together the notes of these various 1907–10 rearings from double matings are sufficient to pose some suggestive queries

By the double mating of silkworms I mean the mating of a female of one race with two males representing different races, one of them usually of the same race of the female, the other of another race Races are chosen which are readily distinguished by a difference in cocoon color, as yellow or white, or in larval pattern, as banded and unbanded The silkworm is polygamous and polyandrous, both males and females usually mating more than once before egg-laying begins Or this repeated mating may continue after egg-laying has begun.

Moths to be experimentally double-mated are reared from carefully isolated cocoons, and the two matings are made to take place immediately following one another for equal or definitely determined unequal periods of coupling, and always before any egg-laying by the female The young produced from the eggs of each double-mated female are reared isolated in separate trays, which are covered over during the later laryal life (possible straggling time)

In any consideration of the results of such repeated mating the unusual way in which the eggs of insects (at least of the silkworm moth and hosts of others) are fertilized must be remembered This way is, simply, that the male fertilizing cells, the spermatozoa, are received by the female at mating into a special sac or receptacle, the spermatheca (there may be several spermathecæ, as in flies) in which the spermatozoa remain alive and active This spermatheca, a diverticulum of the oviduct, is situated near its external opening, the vagina As the unfertilized eggs of the moth pass slowly down from the ovarial tubes into the oviduct they lack only fertilization to be entirely ready for development They have already their full supply of yolk, they are already enclosed in their protecting envelopes (vitelline membrane and outer, firmer chorion) But these envelopes do not completely enclose the egg-mass, there is, at one pole of the egg, one or more small openings, the micropyle, through which the spermatozoa, issuing from the duct of the spermatheca as the eggs pass, enter the eggs As soon as a single spermatozoan has entered, a jelly-like substance closes the micropyle and prevents polyfertilization

Thus when the silkworm moth first mates she receives in her spermatheca, and holds there, a considerable number of spermatozoa representing the heritable characters of the male involved When she couples again she receives another lot of spermatozoa, and if the second coupling is with a male of different race from the first these spermatozoa represent a new set of characters. What is going to be the result of this double mating as exhibited in the offspring?

It seems, at first thought, that this result

[1] "Inheritance in Silkworms, I," *Leland Stanford Junior University Publications*, University Series, No 1, 89 pp, 4 plates, 2 text figs, 1908 Address Librarian, Stanford University, California

should be nothing new, nothing surprising We know already what to expect in any simple mating of different races of silkworms As regards larval pattern and cocoon color the inheritance behavior is usually Mendelian "Moricaud" (all dark) larval pattern is dominant over "tiger," or banded, pattern, banded pattern is dominant over unbanded (all light) Yellow cocoon color is dominant over white And the relation of dominant and recessive is of the usual Mendelian character in F_1, F_2, F_3 and succeeding generations Now although there are two kinds (two races representing these alternative larval and pupal characters) of spermatozoa in the spermatheca of double-mated females, presumably but one spermatozoid finds its way into the egg, and fuses its nuclear matter with the egg nucleus That is, the female, although double-mated, is presumably only single-fertilized.

As a matter of fact the inheritance behavior of the F_1 and succeeding generations derived from these double-mated females does not seem to bear out the simple presumption just stated. The presence in the body (spermatheca) of the female of two kinds of spermatozoa seems to disturb matters The comfortable simplicity and regularity of Mendelian inheritance fails to maintain itself The troubles of irregularity which have not been wholly wanting even in single mating silkworm experiments—and which I have termed in my account of several years' experience of these matings, "strain and individual idiosyncrasies," a term not looked on with favor by thorough-going Mendelians—these irregularities are accented in the double-mating experiments. The irregularities indeed almost assume a seeming of regularity, a non-Mendelian regularity, if such a heresy is admissible

I shall not try to give here the full data of my 85 "double-mating" lots of 1910. But I shall give a considerable number of examples and a general statement of these results. Later, if worth while, all the data can be given; together, I may add, with the results of three or four years' more work in single-mating crossings to test further the inheritance of certain egg, larval and cocoon characters, already pretty fairly determined by the original series of several years whose results have been published

I shall limit the examples referred to in this paper to matings among three races and shall refer only to cocoon characters. The three races are Istrian Yellow, a strong Austrian race producing large golden yellow cocoons, French Yellow, a race producing smaller, salmon yellow cocoons, and Bagdad White, a Turkish race producing large pure white cocoons Bagdad White is a race whose white cocoon color, instead of being regularly recessive to yellow in crossings with yellow cocooning races, is sometimes dominant, as I have shown in my 1908 report (pp 24–25, section on "strain and individual idiosyncrasies") All these races have been bred as pure races by me for the last ten years, that is, races faithfully transmitting certain larval and cocoon characters

In 1908 a Bagdad White female was mated with a French Yellow male from 9 55 A.M. to 11 55 A.M and with a Bagdad White male from 11 55 A.M to 1 55 P.M. The young, reared in 1908, were all white cocooners One mating (1908) (single) among these young produced (1909) 111 white cocoons and 44 yellow cocoons, another produced all white cocoons; also another produced all white cocoons A mating (1909) between two white cocooners out of the 111 white and 44 yellow lot, produced (1910) all white cocoons A mating of two yellow cocooners produced (1910) 8 white cocoons and 40 yellow cocoons, another produced 9 white cocoons and 29 yellow cocoons. A mating (1908) between two white cocooners of one of the all white cocoon lots produced (1909) all white cocoons, and so did another. A mating (1909) of two white cocooners of one of these all white cocoon lots produced (1910) 15 white cocoons and 2 yellow cocoons (sick lot); another produced all white cocoons. A mating (1909) of two white cocooners from the other all white cocoon lot produced (1910) 17 white cocoons and 4 yellow cocoons; and another produced 14 white cocoons (both small sick lots).

In 1907 a Bagdad White female was mated with a Bagdad White male from 9 30 A M to 10 55 A M. and then with a French Yellow male from 10 55 A M to 12 15 P.M From this mating there were produced (1908) 25 white cocoons and 13 yellow cocoons Mating (1908) two of these white cocooners together produced (1909) a small lot divided equally between white cocoons and yellow cocoons (sick lot) Mating (1909) two of these white cocooners together produced (1910) a small lot of white cocooners containing one yellow cocoon (straggler?) (Wherever my records show a single yellow in an otherwise white lot or a single white in an otherwise yellow lot I prefer "straggling" to any other explanation!) A mating (1909) of two yellow cocooners produced (1910) a small yellow lot containing one white cocoon A mating (1908) of a white and a yellow from the 25 white, 13 yellow lot produced (1909) a small lot composed equally of white and of yellow cocooners. Mating (1909) two of these white cocooners together produced (1910) 23 white cocoons and 2 yellow cocoons.

In 1907 another Bagdad White female was mated with a Bagdad White male from 9 30 A M to 10.55 A M. and then with a French Yellow male from 10 55 A M to 12 15 P M From this mating there were produced (1908) 33 white cocoons and 19 yellow cocoons Mating (1908) two of the yellows produced (1909) a small lot equally divided between yellow and white cocoons Mating (1909) two of these white cocooners produced (1910) 9 white cocoons and one yellow Mating (1908) a yellow and a white from the half yellow, half white F_1 generation produced (1909) 22 white cocoons And mating (1909) two of these together produced (1910) a small lot of all white cocooners. Mating (1908) another yellow with another white from the F_1 generation produced (1909) 6 white cocoons and 10 yellow cocoons. Mating (1909) two of these yellow cocooners produced (1910) a small lot equally divided between yellow and white cocoons. Mating (1908) two white from the F_1 generation produced (1909) a small lot all white except for a single yellow cocoon And mating (1909) two of these whites together produced (1910) an all white lot of cocoons

In 1907 a French yellow female was mated with a French yellow male from 9.15 A.M. to 10 45 P M and then with a Bagdad white male from 10 45 A M to 12·15 P M From this mating there were produced 57 white cocoons and 74 yellow cocoons Mating (1908) two yellows of this F_1 generation produced (1909) 22 yellow and 8 white cocoons Another similar mating (1908) produced (1909) 23 yellow and 2 white cocoons And still another produced 14 yellow and 5 white cocoons. Mating (1908) a yellow and a white of the F_1 generations produced (1909) 17 yellow and 19 white cocoons Another similar mating (1908) produced (1909) 21 yellow and 17 white cocoons Mating (1909) two whites of the F_2 generation produced by two yellow parents produced (1910) an all white lot Mating (1909) two more whites of this F_2 lot produced (1910) another all white F_3 lot Mating (1909) two yellows from this same F_2 lot produced (1910) an all yellow lot Mating (1909) another pair of these F_2 yellows produced (1910) 20 yellow and 9 white cocoons Mating (1909) two whites of the F_2 generation produced by a white × yellow produced (1910) 25 whites, 11 yellows and a double cocoon spun together by a white cocooning larva and a yellow cocooning larva Another mating (1909) of two whites from this same F_2 lot produced (1910) 19 white cocoons and 6 yellow cocoons.

In 1907 a French Yellow female was mated with a Bagdad White male from 9 40 A.M to 11 10 A M and then with a French Yellow male from 11 10 A M on to the death of the moths This mating produced (1908) 14 white cocoons and 140 yellow cocoons. Mating (1908) two of the white cocooners produced (1909) 30 white cocoons and 10 yellow cocoons Mating (1909) two of these F_2 generation white cocooners produced (1910) 69 white cocoons and no yellows. Mating (1908) two more of the F_1 generation white cocooners produced (1909) 20 white cocoons and 10 yellow cocoons. Mating (1909) two of the F_2

generation white cocooners produced (1910) a small sick lot, partly white and partly yellow Mating (1909) two of the F_2 generation yellow cocooners produced (1910) a small weak lot of 12 yellow cocoons and 2 white cocoons Mating (1908) two of the F_1 generation yellow cocooners produced (1909) 18 yellow cocoons and 2 white cocoons Mating (1909) two of the F_2 yellow cocooners produced 4 yellow cocoons and one white cocoon Mating (1908) two more of the F_1 generation yellow cocooners produced (1909) 59 yellow cocoons and no white cocoons Mating (1909) two of these F_2 yellow cocooners produced (1910) 47 yellow cocoons and no white cocoons Mating (1908) a yellow cocooner and a white cocooner of the same F_1 generation lot produced (1909) 18 white cocoons and 14 yellow cocoons Mating (1909) two of these F_2 white cocooners together produced (1910) 29 white cocoons and 11 yellow cocoons Mating (1909) two of the yellow cocooners of the F_2 lot produced (1910) a sick lot of 3 white cocoons and 1 yellow cocoon Mating (1908) another yellow and white pair of the same F_1 lot produced (1909) 10 white cocoons and 10 yellow cocoons Mating (1909) two of these white cocooners produced (1910) 93 white cocoons and 25 yellow cocoons Mating (1909) two of the F_2 yellow cocooners produced (1910) 8 white cocoons and 35 yellow cocoons

In 1907 a French Yellow female was mated with a Bagdad White male from 9 40 A M to 11 10 A M and then with a French Yellow male from 11 10 A M to 12 25 P M This mating produced 56 salmon (i e, pinkish yellow) cocoons and 34 salmon to golden yellow cocoons (All of these in the general category yellow but varying in shade from pinkish yellow to deep old gold yellow) Mating (1908) two salmon cocooners produced (1910) 13 salmon cocoons and 3 white cocoons Mating (1909) two of these F_2 salmon cocooners produced (1910) all salmon lot. Mating (1908) another salmon F_1 pair produced (1909) 17 salmon cocoons and 8 white cocoons. Mating (1909) two of these F_2 salmon cocooners produced (1910) 10 salmon cocoons and 6 white cocoons.

So much for double matings between Bagdad Whites and French Yellows Now for a series between Bagdad Whites and Istrian Yellows.

In 1907 an Istrian Yellow female was mated from 9 A M to 10 30 A M with an Istrian Yellow male and then from 10 30 until 12 with a Bagdad White male This mating produced (1908) 55 yellow cocoons and one (straggler?) white cocoon Mating (1908) two of the yellow cocooners produced (1909) 10 white cocoons and 23 yellow cocoons Mating (1909) two of these yellow cocooners produced (1910) 2 white cocoons and 12 yellow cocoons Mating (1908) another pair of yellow cocooners of the same F_1 lot produced (1909) 13 white cocoons and 28 yellow cocoons Mating (1908) still another yellow pair from the same F_1 lot produced (1909) 10 white cocoons and 24 yellow cocoons Mating (1909) two of these white cocooners produced (1910) 4 white cocoons and no yellows Mating (1909) two yellow cocooners of the same F_2 lot produced 16 white cocoons and no yellow cocoons

In 1908 an Istrian Yellow female was mated with a Bagdad White male from 10 30 A M to 12 M and then with an Istrian Yellow male from 12 to 1 30 P M This mating produced 30 yellow cocoons Mating (1909) two of these yellows produced (1910) 16 yellow cocoons and 4 white cocoons Mating (1909) another pair of the F_1 yellows produced 19 yellow cocoons and 4 white cocoons

In 1907 a Bagdad White female was mated with a Bagdad White male from 9 45 A.M to 11 A M and then with an Istrian Yellow male from 11 A M. to 12·15 P M This mating produced (1908) 15 white cocoons and 57 yellow cocoons Mating (1908) two of these white cocooners together produced (1909) 11 white cocoons and no yellows. Two other pairs of white cocooners from the same F_1 lot produced (1909) small all white lots. From each of these three all white F_2 lots was mated (1909) one pair, and each mating produced (1910) a very small weak all white lot Mating (1908) two yellow cocooners from the original F_1 generation lot produced (1909) 22 yellow cocoons and 6 white cocoons. Mating

(1909) two of these white cocooners produced (1910) 35 white cocoons and no yellows Mating (1909) two yellow cocooners produced 24 yellow cocoons and no whites Mating (1908) another pair of F_1 yellow cocooners produced (1909) 9 white cocoons and 20 yellow cocoons Mating (1909) two of these white cocooners together produced 25 white cocoons and no yellows. Mating (1909) two of the yellows together produced (1910) 12 white cocoons and 21 yellow cocoons Mating (1908) another pair of yellow cocooners from the original F_1 lot produced (1909) 4 white cocoons and 17 yellow cocoons Mating (1909) two of these yellow cocooners together produced 8 white cocoons and 20 yellow cocoons Mating (1908) a yellow cocooner and white cocooner of the original F_1 lot produced (1909) 12 white cocoons and 12 yellow cocoons Mating (1909) two of these white cocooners produced 19 white cocoons and no yellows Mating (1909) two of the yellow cocooners produced (1910) 10 white cocoons and 17 yellow cocoons Mating (1908) another yellow and white pair produced (1909) 16 white cocoons and 20 yellow cocoons Mating (1909) two of these white cocooners produced (1910) 6 white cocoons and no yellows Mating (1909) two yellows produced (1910) 8 white cocoons and 6 yellow cocoons Mating (1909) a yellow and a white produced (1910) 4 white cocoons and 12 yellow cocoons Mating (1908) another yellow and white pair produced (1909) 5 white cocoons and 31 yellow cocoons Mating (1909) two of these whites produced 19 white cocoons and no yellows Mating (1909) two of the yellows produced 9 yellow cocoons and no white cocoons

In 1907 a Bagdad White female was mated with an Istrian Yellow male from 9 45 A.M to 11 A M and then with a Bagdad White male from 11 A M to 12 15 P M This mating produced 41 white cocoons, many of them creamy white instead of the pure or faintly greenish-white characteristic of the Bagdad white race Mating (1908) two of these white cocooners produced (1909) 59 white cocoons And mating (1909) two of these F_2 white cocooners produced (1910) a small all white lot Similar F_2 and F_3 all white lots were obtained from another F_1 mating Mating (1908) another pair of F_1 white cocooners produced (1909) 46 white cocoons and 15 yellow cocoons Mating (1909) two of these white cocooners produced (1910) a small all white lot Mating (1909) two of these F_2 yellow cocooners produced (1910) an all yellow lot

In 1907 a Bagdad White female was mated with an Istrian Yellow male from 9 45 A M to 11 A M and then with a Bagdad White male from 11 A M to 12 15 P M (This was an exact duplicate of the 1907 double mating just described) This mating produced (1908) 48 white cocoons and 20 yellow cocoons Mating (1908) two of these white cocooners produced (1909) a small all white lot, and a mating (1909) of two from this lot produced (1910) a smaller all white lot Mating (1908) another white pair from the F_1 generation produced an all white lot, and a mating (1909) of two from this lot produced (1910) a small all white F_3 lot Mating (1908) two yellow cocooners of the F_1 lot produced 9 white cocoons and 12 yellow cocoons Mating (1909) two of these F_2 white cocooners produced a small all white lot, while mating (1909) two of the yellow cocooners produced (1910) a very small all yellow lot Another mating (1908) of two yellow cocooners of the original F_1 lot produced 26 yellow cocoons and one white cocoon and mating (1909) two of these F_2 yellow cocooners produced (1910) 14 yellow cocoons and 2 white cocoons Another mating (1908) of two yellow cocooners from the original F_1 lot produced 28 yellow cocoons and 12 white cocoons Mating (1909) two of these F_2 yellow cocooners produced 50 yellow cocoons and no white ones, while mating (1909) two of the white cocooners produced (1910) 15 white cocoons and 1 yellow cocoon (straggler?). Mating (1908) a yellow and a white from the original F_1 lot produced (1910) 40 white cocoons and 16 yellow cocoons Mating (1909) two of these white cocooners produced (1910) 28 white cocoons and 29 yellow cocoons, while mating (1909) two of the F_2 yellow cocooners produced (1910) 5 white cocoons

and 34 yellow cocoons. Another mating (1908) of a yellow cocooner and a white cocooner from the original F_1 lot produced (1909) 20 white cocoons and 19 yellow cocoons. Mating (1909) two of these white cocooners produced (1910) 70 white cocoons and no yellow ones, while mating (1909) two of these F_2 yellow cocoons produced (1910) 6 white cocoons and 9 yellow cocoons.

In 1907 a Bagdad White female was mated with a male Istrian yellow from 9.40 A.M. to 10.45 A.M. and then with a male Bagdad White till death of the moths. This mating produced (1908) 29 yellow cocoons. Mating (1908) two of these yellow cocooners produced (1909) 25 yellow cocoons and 8 white cocoons. Mating (1909) two of these F_2 whites produced (1910) a small all white lot. Mating (1908) another pair of the F_1 yellow cocooners produced (1909) 6 white cocoons and 12 yellow cocoons. Mating (1909) two of these F_2 white cocooners produced (1910) an all white lot. Mating (1909) two of the yellow cocoons produced 9 yellow cocoons and 6 white cocoons. Mating (1908) another pair of the F_1 yellow cocooners produced (1910) 30 yellow cocoons and 9 white cocoons. Mating (1909) two of these yellow cocooners produced (1910) an all yellow lot. Mating (1908) still another pair of the F_1 yellow cocooners produced (1909) 19 yellow cocoons and 4 white cocoons. Mating (1909) two of these F_2 yellow cocooners produced (1910) 29 yellow cocoons and 5 white cocoons.

These are the records. Their interpretation may be made by any one interested. In scrutinizing them for significance this should be remembered. In ordinary (single) matings of Bagdad White with Bagdad White only white cocoons are produced in F_1 and all following generations. In mating French Yellow with French Yellow or Istrian Yellow with Istrian Yellow only yellow cocoons are produced in F_1 and all following generations. In mating Bagdad White with Istrian Yellow usually all the cocoons of the F_1 generation are yellow. Mating these together usually produces in F_2 generations 3 yellow to 1 white, the Mendelian behavior. In mating Bagdad White with French Yellow the dominance of yellow is not so steadfast. There is, as I have shown and particularly emphasized in my 1908 paper, more or less aberration from the Mendelian rules in this mating. And indeed, these aberrations are likely to occur in any other crossing of silkworm races. The usual inheritance behavior of silkworm cocoon characters is, however, Mendelian. The aberrations constitute what I have called "strain and individual idiosyncrasies." This simply means that I believe that there is more in the order of inheritance than is covered by Mendelism. The Mendelian elements in this order are becoming recognizable and familiar. The other elements are not yet so obvious to us.

In these double matings the aberrations are abundant and conspicuous. After a double mating the whites of the F_1 generation mated with other whites of the same generation do not always produce whites. They may produce both yellows and whites. Or this latent carrying of the yellow character by these presumably strictly recessive (white) carriers may not be manifest till an F_3 generation. What does this mean?

In seeking an answer, the state of affairs as regards actual fertilization in these double mating cases must be kept in mind.

The female receives during an hour's or two hours' coupling a large number of fertilizing cells from a male of her own race (and hence her own cocoon characters). She then receives during another hour's or two hours' coupling a presumably equal number of germ cells from another male of different race (and different cocoon characters). These two lots of active spermatozoa are held in the spermatheca. Is one group above or in front of the other, so that when an egg arrives opposite the opening of the spermatheca it will necessarily be fertilized by one of this upper or front group (the group provided by the second male)? Or do the actively motile spermatozoa become thoroughly mingled in their fluid vehicle so that access to the egg will be according to the law of probabilities? More likely the latter alternative should prevail.

When, however, a spermatozoan enters the egg through the micropyle this micropyle should, by analogy with the observed conditions in various other insect eggs, become closed, thus preventing poly-fertilization If this is so then a double mating should after all result in but a single fertilization, and these fertilizations should be roughly divided between the two male types

Thus in double mating a female Bagdad White with Bagdad White and Istrian Yellow males, the fertilizations should be, roughly, equally divided between pure race Bagdad White and crossed Bagdad and Istrian Yellow And in accordance with these fertilizations half of the F_1 generations thus produced should be white cocooning and half yellow cocooning (yellow being dominant in crossings with white) If an Istrian Yellow female is mated with both Istrian Yellow and Bagdad White males F_1 generations should always be composed of all yellow cocooning individuals Or if in these double matings all of the fertilizations are effected by spermatozoa of one of the males only then the F_1 lots should be either all white cocooning or all yellow cocooning F_2 generations from these lots should follow the Mendelian order and break when the F_1 individuals are hybrids and not break when they are pure race progeny

But the data given above do not reveal the expected behavior They evidence a considerable perturbation in the order of inheritance The F_1 lots are not always all white or all yellow, or equally divided between white and yellow as they seemingly should be Or if such all white or all yellow F_1 lots are produced, they often throw both yellows and whites in F_2 lots when only yellows or only whites should have appeared. Or if they do produce all white or all yellow F_2 lots intermating in these lots may produce both yellows and whites in F_3 lots. In a word the inheritance behavior is not that which it should be in animals usually following a Mendelian order, if the only influence at work on the egg is the nuclear content of a single pure race spermatozoan.

What, then, is causing this pertubation in the order of inheritance? Do the eggs in double-mated females receive more than one spermatozoan and are these spermatozoa often the representatives of both the races used in the double mating? Or can the egg be in any way influenced by the mere presence in the spermatheca of spermatozoa representing both of a pair of allelomorphic heritable characters? Can fluids carrying the spermatozoa have any influence during fertilization? Can the spermatozoa of one type influence those of the other type during their enforced companionship for several hours or days in the female spermatheca?

All that we think we know of the mechanism of fertilization and heredity makes us answer "No" to each of these questions Then why should the order of inheritance in the silkworm moth be different in the generations after these double matings from the order in the generations following a single mating?

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SOCIETIES AND ACADEMIES

THE NATIONAL ACADEMY OF SCIENCES

AT the stated meeting of the academy on April 18–20, the following papers were read

"On the Motions of the Brighter Helium Stars," W W Campbell

"Report of Progress in Spectrographic Determinations of Stellar Motions," W W Campbell.

"The Evolution of Periodic Solutions of the Problem of Three Bodies," F R Moulton

"Mechanical Quadratures," G. F Becker

"Corollaries of the Theory of Isostasy," W M Davis

"Experimental Investigation on Reflection of Light at Certain Metal-liquid Surfaces," Lynde P. Wheeler (introduced by C H Hastings).

"On the Origin of the Peaks of Maximum Pressure in the Midst of the Permanent Tropical Oceanic Highs," W J Humphreys (introduced by Cleveland Abbe).

"A Further Study of Columbic and Tantallic Oxides," E. F. Smith.

"The Outlook of Petrology," J. P Iddings

"The Orogenic Development of the Northern Sierra Nevada," Waldemar Lindgren.

"Biological Conclusions drawn from the Evolution of the Titanotheres," H F Osborn

"A New Reptile from the Newark Beds," W B Scott

"Restorations and Ontogeny of the Eurypterids," J M Clarke

"A Geological Reconnaissance in the Rocky Mountains of British Columbia," Chas D Walcott

"Comparative Study of the Early Stages of Vertebrates," C S Minot

"Infantile Paralysis and its Mode of Transmission," Simon Flexner (read by C S Minot)

"Cell size and Nuclear size," E G Conklin

"The Cause of Death of the Unfertilized Egg and the Cause of the Life-saving Action of Fertilization," Jacques Loeb

"Studies of the Pulmonary Circulation," Horatio Wood, Jr (introduced by H. C Wood)

"An American Lepidostrobus," J M Coulter

"Aristotle's History of Animals," Theo Gill

"Notes on New England Mollusca," E S Morse

"Changes in Bodily Form of Descendants of Immigrants," Franz Boas

"Classification of Shoshonean Tribes," C Hart Merriam

"The Outside and the Inside of the Yosemite Indian," C Hart Merriam

"Biographical Memoir of W H C Bartlett," E S Holden

"Biographical Memoir of C B Comstock," H L Abbot

"Biographical Memoir of S W Johnson," T B Osborne

"Biographical Memoir of Benjamin Silliman, 1816–1885," A W Wright

"Biographical Memoir of James H Trumbull," A W Wright

"Biographical Memoir of C A White," Wm H Dall

"Biographical Memoir of Joseph Leidy," Henry Fairfield Osborn

THE AMERICAN MATHEMATICAL SOCIETY

THE one hundred and fifty third regular meeting of the society was held at the University of Chicago on Friday and Saturday, April 28–29, 1911, the occasion being especially marked by the presidential address of Professor Maxime Bôcher on "Charles Sturm's Published and Unpublished Work on Differential and Algebraic Equations" This was the first regular meeting of the society, except the summer meetings, that has been held elsewhere than in New York city The attendance exceeded all previous records, reaching a total of 115, including 88 members. Fifty three papers were presented at the four sessions

The president of the society, Dean H B Fine, of Princeton University, occupied the chair, being relieved by Professor G A Miller and Vice president G A Bliss The council announced the election of the following persons to membership in the society Professor H Bateman, Bryn Mawr College, Mr Samuel Beatty, University of Toronto, Professor J H Griffith, University of Michigan, Mr E J Moulton, Harvard University, Mr George Spitzer, Agricultural Experiment Station, Purdue University, Professor C J West, Ohio State University Eleven applications for membership in the society were received

Professor L E Dickson was reelected to the editorial board of the *Transactions* for a term of three years A committee was appointed to arrange for the summer meeting and colloquium to be held at the University of Wisconsin in 1913

Friday evening was devoted to the usual dinner, at which 73 members were present

The following papers were read at this meeting

Daniel Buchanan "A class of periodic solutions of the problem of three bodies, two of equal mass, the third moving in a straight line"

H E Buchanan "An expansion of elliptic functions with applications"

D R Curtiss "Relations between the Gramian, the Wronskian, and a third determinant connected with the problem of linear dependence"

L L Dines "On the representation of resultants of polynomials in one variable"

L L Dines· "On the solution of three equations for three variables in terms of others"

W D MacMillan "A reduction of a system of power series to an equivalent system of polynomials"

W D MacMillan· "A method for finding the solutions of a set of analytic functions in the neighborhood of a branch point"

R L Moore "On the transformation of double integrals"

Maxime Bôcher (presidential address) "Charles Sturm's published and unpublished work on differential and algebraic equations"

L P Eisenhart· "A fundamental parametric representation of space curves"

A E Young "On certain orthogonal systems of lines and the problem of determining surfaces referred to them"

Arnold Emch "The differential equation of curves of normal stresses in a plane field."

A B Frizell. "A set of postulates for well ordered types"

C J Keyser· "Sensuous representation of paths that lead from the inside to the outside of

an ordinary sphere in point four space without penetrating the surface of the sphere"

Edward Kasner "The subdivision of curvilinear angles"

R D Carmichael "The general theory of linear q difference equations"

R D Carmichael "Note on multiply perfect numbers"

G A Miller "Isomorphisms of a group whose order is a power of a prime"

R. G D Richardson "Theorems of oscillation for two self adjoint linear differential equations of the second order with two parameters (second paper)"

J B Shaw. "Quaternion functions of three parameters"

J E Rowe "The combinants of two binary cubics and their geometrical interpretation on the rational cubic curve"

U G Mitchell "Geometry and collineation groups of the finite projective plane $PG(2, 2^3)$"

G E Wahlin "The decomposition of rational primes into ideal prime factors in the field $k(\sqrt[p]{m})$"

L C Karpinski "An Italian Algebra of the fifteenth century"

C H Sisam "On hyperconical connexes in a space of r dimensions"

R E Root. "Iterated limits of functions on an abstract range"

E B Van Vleck "On the generalization of a theorem of Poincaré"

E B Van Vleck "On the classification of collineations"

A R Schweitzer "On the philosophy of Grassmann's extensive algebra"

A R Schweitzer "On the 'working hypothesis' in the logic of mathematics"

W B Ford "A set of sufficient conditions that a function may have an asymptotic representation in a given region"

W J Montgomery "The classification of twisted curves of the fifth order"

William Marshall· "On Hill's differential equation in the theory of perturbations"

H Bateman "The fundamental equations of the theory of electrons and the infinitesimal transformation of an electromagnetic field into itself"

N J Lennes "Curves and surfaces in analysis situs"

N J Lennes· "Extension and application of a theorem of Ascoli."

L I Neikirk. "Substitution groups of an infinite degree and their related functions"

James Maclay: "Parabolic curves"

J. A Nyberg· "Projective differential geometry of rational cubic curves"

E B Stouffer. "Invariants of linear differential equations with applications to ruled surfaces in five dimensional space"

W D MacMillan "A general existence theorem for periodic solutions of differential equations of a certain type"

A R. Crathorne "The catenary with variable end points"

F R Moulton "Periodic orbits of superior planets"

F R Moulton "On the curves defined by certain differential equations"

F H Safford "An identical transformation of the elliptic element in the Weierstrass form"

W H Roever "Southerly deviation of falling bodies (third paper)"

C N Moore "Convergence factors in double series"

L E Dickson "On the negative discriminants for which there is a single class of positive primitive binary quadratic forms"

L E Dickson "On Fermat's 'descente infinie'"

L E Dickson "On perfect numbers and Bernoullian numbers"

O E Glenn "On expressing a quantic in terms of assigned powers of a given quantic"

G R Clements "Implicit functions defined in the neighborhood of a point where the Jacobian determinant is zero"

R W Marriott "Determination of the groups of isomorphisms of the groups of order p^4"

The summer meeting of the society will be held at Vassar College on Tuesday and Wednesday, September 12-13

F N COLE,
Secretary

THE AMERICAN PHILOSOPHICAL SOCIETY

AT the stated meeting of the society on April 7, Rear Admiral G W Melville (U S Navy, retired) read a paper on "A Century of Steam Navigation"

The author said In looking back over the history of the human race we are struck with the fact that from time to time some genius brings to light, or develops a principle which forever after is a guide in our thinking Such was Lord Bacon's exposition of inductive logic, which has been the basis of all scientific advancement

Basing his argument on the above theory, the admiral followed the growth of steam navigation from the time of the inventions of James Watt, down to the time of Fulton's first commercial steamer *Clermont*, down to the time of the *Lusitania* and *Mauretania* of to day

He spoke of the varied improvements from that time up to the present time, including the many improvements, not only in ships and ship building from the wooden hulls to the present steel hulls, but the engines and boilers through their various stages of improvements, commencing with a low steam pressure of 10 pounds to the square inch up to the present time of about 300 pounds pressure per square inch

He traced through the various steps the great evolution of steam ships from those of about 500 tons to those of 40,000 tons Of necessity in a short lecture of but 40 or 45 minutes, a very

rapid tracing of the growth of steam navigation and marine engineering had to be quite limited. Nevertheless, the lecture seemed to be of great interest to his audience. And the fact of the growth of steam ships from the paddle wheels used to a large extent in the forties of the last century, through the propeller systems, and finally of the great advances made through the steam turbine, which is only an improvement of Heroes's steam turbine of 2,000 years ago.

He mentioned the famous steamer *Great Eastern*, which was a wonder in her day, which is nearly a half century ago. She was simply about fifty years in advance of her time, for although a great engineering success, she was not a commercial success, which is the real measure in these days of what is considered a success in commercial life.

He laid great stress on the improved material with which the engineer could work to day, without which it would be impossible to build the great vessels of 30,000 tons displacement, and 70,000 horsepower.

Another fact which he pointed out, and which is worth noting, was that high speeds properly belong to big ships, because experiments had shown that for a higher speed the resistance of a large ship per ton of displacement was very much less than that of a small one.

He dwelt upon the different types of battle ships, from the *Dreadnought* type down to the small torpedo boat and torpedo-boat destroyer, stating that in naval construction it was necessary to have the various classes of ships to fill their particular positions in the battle fleet, the same as the different arms of the service in the army, such as artillery, cavalry, infantry, etc.

After the lecture illustrations were made of the lecture proper, by means of a series of illuminated lantern slides.

THE PHILOSOPHICAL SOCIETY OF WASHINGTON

THE 694th meeting was held on April 22, 1911, Vice-president Fischer in the chair. The following paper was read:

The Scientific Aspects of the President's Inquiry into Economy and Efficiency: DR. F. A. CLEVELAND, chairman, Committee on Economy and Efficiency.

The work that the committee had been asked to do was mentioned, and which, briefly stated, is that it was to make such concrete recommendations to the president as would enable him to act with greater economy and efficiency in the management of the business affairs of the government.

At the beginning there was little of scientific information of how the large business concerns of the government are organized or what the government is doing. The committee felt a grave responsibility. It assumed in the start that for progress and commendable results it was necessary to focus the attention of all in the service upon the subject of administration. This required a working hypothesis or common plan of cooperative effort or coordination. As the whole of this inquiry looks to something constructive, it first had to be decided what sort of information is needed by the man who is responsible for the conduct of the government's business.

The first work was to find out how the government is organized and what it is doing. The president asked each head of department to cooperate with the White House, and under their supervision the inquiries have been conducted. Diagrams and charts were exhibited showing the departmental organizations in their different divisions and branches and their activities, and how they are connected up and coordinated, these being based upon the reports and outlines of organization prepared by the several departments.

In describing the organization of the government's work, the speaker remarked in passing that one is really amazed when he knows what wonderful organizations some of the government offices are.

Reports were also secured describing the legal powers of the various departments and divisions of the government service throughout the country in order to ascertain the authority for the various activities pursued, and in these matters also the committee had appealed for their information to the men in the service who had been living the parts, to those directly concerned.

The committee assumed that the cost of the government's activities should be known, and that all should know that the administration of the government's affairs is economical. To ascertain this it is necessary to know, (1) that a thing is bought, (2) what is bought and (3) is it suitable for the purpose for which it is bought. Also in studying economy the relation of cost to results must be known.

The analysis of the costs of the government's activities in terms of administration, operation and maintenance were discussed, and how the analysis was applied in arriving at standards of judgment of costs in relation to results.

R. L. FARIS,
Secretary

SCIENCE

FRIDAY, MAY 26, 1911

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THE NEW HARVARD ENTRANCE REQUIREMENTS[1]

IN this address (a free abstract of which, written out later, is here given) it should be clearly borne in mind that the speaker is familiar only with eastern admission arrangements, and that what he says is wholly from the point of view of an eastern institution, with its own problems, in some respects different from those which meet the schools and universities of the west. Indeed, a knowledge of the real entrance requirements in any institution, as distinguished from the catalogue rules, can be gained only from an acquaintance with actual practise, for in the nature of the case the real requirements depend on the mode of administering the rules.

I

The earlier entrance requirements at Harvard, as at all contemporary institutions, were determined by the fact that the subjects studied in school were generally to be continued in college. It was accordingly necessary to know whether a boy who applied for admission had reached the point in Latin, Greek and mathematics where he would be able to go on with college work in those subjects. This was substantially the case until soon after the beginning of the administration of President Eliot in 1869. A process of radical modification in the Harvard entrance requirements then began, and at successive periods since, about ten years apart, there have been important and far-reaching changes.

[1] Address at the annual meeting of the Michigan Schoolmasters' Association, Ann Arbor, Mich., March 31, 1911.

The chief points in these changes appear to have been three · (1) a substitute for Greek has been provided, (2) with the development of the elective system the subjects studied by college students have in most cases become different from those which they have pursued in their school courses, and it is consequently necessary to learn not the degree of their attainment in Latin, Greek and mathematics, but whether they are competent to carry on studies in history, economics, modern languages and science; (3) it has been intended to aid the schools by setting in the several examinations a standard for school work to which the schools can hold up their boys. In pursuance of this last idea there has been a tendency to provide examinations in some subjects in which hardly any boys were likely to offer themselves, but which some schools wished to teach, and in which the college was told that such an examination standard would be found valuable

In the successive changes made at Harvard, chiefly in 1871, 1878, 1886 and 1898, can be seen the working of these various motives, and especially can be traced a gradual process by which the substitute admitted for Greek, at first partial, has become complete, and has finally been made not much, if at all, more difficult than the Greek requirement

The present plan of Harvard entrance requirements was adopted by the faculty in 1898, although the form of statement has since become somewhat changed. It includes a large number of optional subjects, many of them having a weight of not more than one "point" in the system. These options are in some (and the most important) cases real, in the sense of being practically available for schools, but in most cases they are illusory, because very few of the schools from which boys come are equipped to fit boys in these less usual subjects The chief technical peculiarity of the Harvard system is that the numerical values attached to the different subjects are not based wholly on the relative time supposed to have been expended on those subjects in the high-school course, but have been adjusted on the theory that work done in the last two years of the high-school course ought to be given a higher rating than the work of younger boys Accordingly, in determining the "ratings" a coefficient was introduced corresponding to the stage in the school course at which the subject would commonly be studied.

II

Under this system of complete examinations for all high-school studies, which differs but little in theory from that of the other eastern institutions where examinations are required, some good results have been felt in the schools from the establishment in certain fields of study of definite standards tested by a college examination, and in general the system has provided a method, though an imperfect one, of selecting from the whole body of applicants those who were best fitted to undertake college work. About 75 per cent. of those applying have usually been admitted to the freshman class, as is shown in the table given below. At the same time certain bad results have been more and more clearly perceived, both from the point of view of the college and from the side of the schools The latter, indeed, have not been slow to present complaints And these bad results seem to be necessarily consequent upon the system itself. The gradual perfecting of an inherently defective type of machine has naturally brought out more and more clearly the working of its defects.

1 The system has resulted in loading a

large part of the freshman class, usually amounting to one half or more, with entrance conditions, and thereby making more difficult the task of the weaker members of every entering class From the college point of view this difficulty has become intolerable, since it prevents the establishment of a proper pace of work for freshmen

2 The Harvard system of examinations can ordinarily be prepared for without serious difficulty by any school which devotes itself mainly or largely to that end, and which boys attend for three or four years before entering college and with the purpose of fitting themselves for Harvard It is not, however, adjusted to the courses of many excellent schools throughout the country—schools wholly occupied with substantial academic subjects and doing first-rate work in those subjects, and it is likely to exclude any boy who makes up his mind late in his school course that he wishes to go to Harvard In other words, it is a system which was natural so long as resort to Harvard was wholly from private and endowed schools and a half dozen public high schools which made a business of fitting for Harvard and other eastern institutions. If Harvard is to offer the melting pot of a common academic life to boys from many parts of the country, it must adapt itself to the best systems of public education maintained in those widely distant regions. By dictating the whole school course as it does, the present Harvard entrance system unduly restricts the possibility of resort to Harvard College from other schools than that very small number which have for one of their primary objects to be Harvard fitting schools

3. As a method of selecting the best from the whole body of applicants for admission to the freshman class, the present system is imperfect It admits to the class a certain number of boys who can do nothing well, but have been crammed to pass every one of the examinations with the lowest pass mark These boys often get in clear of conditions, but usually come to grief in the first semester. A satisfactory system would exclude them from admission On the other hand, some have to be rejected who would do well in college if they once got in

Harvard College does not crave any considerable increase in numbers What it does desire is the resort of about the same number of young men, but of better students from a wider range of territory We should like, not a larger number of freshmen, but a larger number of applicants from whom we could make our selection of the best

As the three evil results already mentioned are observed from the side of the college, so the two following have been urged, and it is believed with justice, by the schools

4 A system of examinations which, like the present one, aims to test every subject studied in a four-year school course makes it necessary for every subject to be continued in the course in some form until the time for the examinations Under the system of the German gymnasium the subjects are practically all carried down to the close of the last year, the stream of the minor subjects being kept slender yet sufficient to maintain the flow. The American school system is of a different character, and consequently it is necessary for the American school to review in the last year, or the last two years, those subjects upon which the boy is presently to be examined. This produces a spirit of "cram," deeply regretted by the school-masters, together with a serious overcrowding of the last year, or two years, of the school course.

An elaborate examination of school programs from good schools in different parts of the country recently made at Harvard has fully convinced us that the complaints of the schoolmasters in this matter are justified. If it be urged that the examinations can now be spread over three years, it is to be observed that the college examinations are necessarily adapted to the stage of maturity of boys nearly ready to enter college, and are, consequently, for the most part out of the range of a boy completing the second year of his high-school course

5 Under the present system of entrance to Harvard College, not only is the course of study in the schools fixed from above, but also the methods of teaching have been dictated by the college This has taken from the schools freedom to experiment with their own methods of education, a freedom which able and enterprising teachers crave, and ought to have A certain relief, it must be said, has been found here in the examinations of the College Examination Board, but it appears to be only a partial one

6 One further bad result upon the schools more directly under the influence of Harvard should be mentioned The examination system has enfeebled their power to take responsibility for the quality of their own product As Harvard has undertaken to test every subject studied in the school course, the school has been responsible for meeting these tests, not for maintaining its own ideal and type of education Indeed, it was hardly open to it to form its own educational ideal or specific type at all

III

These various incidental bad results of the present system have led the Harvard faculty to a complete reconsideration of the principles which ought to govern a plan of entrance requirements, and to the adoption of a new system which, for the present, will be maintained side by side with the old system, the applicant having his choice whether he will come up for admission under one or the other plan

In framing the new system the consideration chiefly in mind has been that entrance requirements must always test two things

1. Whether the applicant has had an adequate school course Inasmuch as a bachelor's degree represents the completion of the whole course of liberal education, it necessarily includes a guarantee that the earlier as well as the later part of the student's education has been adequate in range and intensity. The college is responsible not merely for college work, but also for knowing whether the school work has been devoted to such subjects as, in its opinion, may properly form a part of the education finally attested by the bachelor's degree

2 What result has been accomplished by such a course of school study in developing effective ability in the individual boy or girl This latter test has for its object to determine whether the applicant is likely to be able to do college work well.

Now these two ends for which college entrance requirements exist are entirely different in nature. The character of the applicant's course of study is a very different thing from the practical result in the boy as he stands. The former can be adequately ascertained by proper inquiry and by inspection of the school course he has actually pursued; the latter can only be determined by recitations, examinations, or some similar test, conducted either by the school or the college. The present examination system undertakes to reach both these ends by one instrument—a system of

examinations The results have been outlined It would seem better to adopt for each of these ends a method directly contrived to accomplish that particular purpose, and not to try to perform two distinct processes by a machine mainly adapted to one only

Both in regard to the course of study and to the result of that study, the school and the college have each a distinct responsibility The general type of school course which is to be accepted as a part of the whole education to be attested by the degree of A B or S B, may, and indeed must, be determined by the college which gives the degree But under that general type the details of curriculum and of methods of instruction are more likely to be effectively arranged by the school itself than by the authorities of the college To deprive the school of its freedom and consequent responsibility is to weaken its power of maintaining and pursuing an educational ideal On the other hand, the testing of the result of the school education belongs to the college, and an adequate test ought to give evidence of general intellectual power, not merely of the faithfulness with which a boy has studied individual subjects at school The idea that an education consists in absolving individual courses, whether at school or college, is, at the present day, the root of much evil

In New England, as elsewhere, one of the difficulties of which the schools have complained has been alleviated by the certificate system, which, through the coöperation of the colleges in the New England Certificating Board is now well organized with strict standards Colleges which thus give to certain schools the privilege of certifying to the preparedness of their graduates for college thereby relax their control, not indeed over the subjects studied, but over the method of instruction in the individual subjects, and this has proved a considerable relief But the certificate system, at least as organized in New England, violates both of the principles which have been laid down above Under it the domination of the college over the topics which are to make up the school curriculum, over the relative weight which shall be given them, and over other details which properly belong to the judgment of the school, is quite as close and harassing as under the examination system On the other hand, that portion of the task which is the rightful prerogative of the college, namely, the determination of how well the schools have done their work, is abandoned by the college and handed over to the headmasters of the schools, who certify, not merely that the boy has done such and such work in his school course, but that, in the opinion of the master, he is fit to enter college. In both these matters the certificate system has reversed the proper procedure, and puts the responsibility on the wrong side

IV

Under the influence of considerations like these, the new plan already spoken of has been adopted at Harvard College The following statement of it has been sent out widely

NEW REQUIREMENTS FOR ADMISSION TO HARVARD COLLEGE

To be admitted to Harvard College, a candidate

(1) Must present evidence of an approved school course satisfactorily completed, and

(2) Must show in four examinations as explained below that his scholarship is of a satisfactory quality:

SCHOOL RECORD

A candidate must present to the committee on admission evidence of his secondary school work in the form of an official detailed statement showing

(a) The subjects studied by him and the ground covered.
(b) The amount of time devoted to each.
(c) The quality of his work in each subject.

To be approved, this statement must show:
(a) That the candidate's secondary school course has extended over four years.
(b) That his course has been concerned chiefly with languages, science, mathematics and history, no one of which has been omitted.
(c) That two of the studies of his school program have been pursued beyond their elementary stages, i. e., to the stage required by the present advanced examinations of Harvard College or the equivalent examinations of the College Entrance Examination Board.

THE EXAMINATIONS

If the official detailed statement presented by the candidate shows that he has satisfactorily completed an approved secondary school course, he may present himself for examinations in four subjects as follows:
(a) English.
(b) Latin, *or*, for candidates for the degree of S.B., French or German.
(c) Mathematics, or physics, or chemistry.
(d) Any subject (not already selected under (b) or (c)) from the following list:

Greek	History	Physics
French	Mathematics	Chemistry
German		

These four examinations must be taken at one time, either in June or in September.

In announcing this plan, the committee on admission wish to point out that it differs in essential principles from the old plan now in use, and that therefore comparisons between the new requirements and the old will be misleading if any attempt is made to express the new requirements in the terms of the old. Under this new plan the college does not intend to prescribe in detail the school course of the boy who wishes to enter, either directly by naming and defining subjects, or indirectly by an elaborate system of rating the studies of a school course in points or units. On the contrary, the college accepts the judgment of a school as to a candidate's program, subject only to the general limitations stated above. It is not necessary, therefore, for a school to fit a candidate's course to detailed definitions of subjects. A good student who has had a rationally planned course in a good school should have no difficulty in proving his fitness for admission, even though his decision to come to Harvard be made late in his last school year. Under the new plan every school maintaining the kind of course indicated will be free to work out its own system of education in its own way. The college, on its part, undertakes only to test the intellectual efficiency of the boy at the time of his graduation from school. For this reason the examinations can not be divided.

A second important difference between the new requirements and the old is the emphasis put in the college examinations upon quality of work. The new plan contemplates examinations different from those now used with respect both to their character and the method in which they will be administered. It is hoped to secure a type of examination which shall be adapted to various methods of teaching, and which shall contain questions sufficient in number and character to permit each student to reveal the full amount and quality of his attainment. In administering examinations under this plan, the committee will always consider examinations in connection with school records, and will endeavor to see not whether a candidate has done a certain prescribed amount of work in a certain way, but whether the general quality of the candidate's scholarship is satisfactory. If a candidate is admitted, he will be admitted without conditions; if he is refused admission, no credit will be given for examinations in the separate subjects in which he may show proficiency, and the refusal will mean that his school record and his college tests do not show that he has the scholarship which makes his admission to Harvard College desirable.

The admission of a candidate under this plan, therefore, depends upon good scholarship as shown in two ways—in his school work and in his college tests. He can not secure admission by scoring points or by working up examinations one or two at a time. He must have done good work in his school according to the testimony of his teachers, and he must meet successfully college tests at the time when he is ready to enter.

In introducing this plan, which departs considerably from schemes of admission now in general use, the college is already aware of various grave difficulties. It will doubtless be difficult to prepare a type of examination paper sufficiently flexible to fit various methods of instruction in various parts of the country, and to enable all candidates to exhibit the full amount and quality of their attainments. To accomplish this end, the committee on admission are authorized to advise

with school teachers in regard to the preparation of papers and the methods and standards of marking, and they confidently hope for the cooperation of schools in working out a plan which they believe will serve the common interests of both schools and colleges

The scheme, as above outlined, aims to determine by inquiry whether the boy's school work shall be counted as a sufficient preliminary education, and then to test by a sufficient number of examinations, not however, covering the whole school course, what has been the result of the education in the boy's power to do intellectual work. Each of these methods seems apt to the end desired, and careful provision has been made for keeping these two inquiries distinct

The essence of the scheme is, in fact, that the admission of boys to college is now entrusted to a committee which is expected to use a large discretion under the limits laid down in the regulations. This committee will assemble a sufficient general knowledge of the schools from which boys come, such knowledge as can now be obtained by various trustworthy methods, even from distant parts of the country. It is further provided, through the certified record of the boy presented by the master of the school and through the results of the examinations, that adequate information on the two points emphasized above will be at the committee's disposal

The restriction upon the type of school which will be allowed to send boys up to become candidates for the bachelor's degree is here made, not, as at present, through the list of examination subjects with their accurate ratings, but through the statement of the course actually pursued by each boy, with the grades attained. The college does not intend to alter at all its policy of requiring that the boy's education shall have consisted mainly of substantial academic subjects. No school course will be accepted which includes any large dilution of manual and technical work

The examinations are to be of a somewhat different type from those hitherto used, or, at any rate, the treatment of the examinations by the readers and by the committee is intended to be different from that which has been given to examinations in the past. The purpose of the examinations is not to test the work of the several courses of the school, but to sample the boy, as a cargo of cotton might be sampled from taking tests from different representative bales. Further, the object of the examination is not to see whether the boy can get a pass-mark in any one, or in all, of the subjects. It will rather be to bring out how much the boy knows. It is hoped that for his free (fourth) subject he will choose the field he can do best in, and so will be given a chance to exhibit himself at his best. Likewise, it is hoped that the schools will now be able to carry boys to more advanced work in those subjects (as, for example, classics or mathematics) in which they are best equipped—for they can do so with the confidence that the result of that special proficiency in certain subjects will be manifest in the examination, and recognized by the admission committee. The marking of the books under the new system will require that in every case a statement by the reader in words shall give his opinion of the actual quality of the boy as exhibited in that examination. There will be no mechanical adding of grades. It will be impossible to enter on a bare pass-mark in the several subjects. Indeed, it is difficult to say under the new system what would constitute "passing" any one examination. The only "passing" that is contemplated is the evidence, ***drawn from the four examinations taken together***, that the boy has at-

tained a satisfactory quality of mind He is expected to make a *creditable* exhibition of himself, and it is hoped that the system will exclude the boy who, under the old system, probably by the aid of a skilful tutor, can just scrape through every examination It is hoped that in good schools the new system will make it easier for the school-master to prepare boys for Harvard, but it is not intended to make entrance to college in any way easier for the *boys*

Inasmuch as the inquiry relates to the intellectual power of the boy at the moment when he stands ready for entrance, it is obvious that the examination can not be divided into preliminary and final For the same reason, the evil of conditions will be wholly eliminated by the new system A boy either is or is not fit to enter college If he is not fit, then he must either abandon the idea or else go back to school and study until he becomes ready There can be no conditions

It is not the intention by the new system either to raise or to lower the "standard" of admission. That is to say, it is hoped that in a four years' course the amount of intellectual effort which a boy has to put out in order to prepare for Harvard will be as before. But a smaller proportion of it will be mere cram.

	1906	1907	1908	1909	1910
Admitted to freshman class . .	576	594	529	573	565
Rejected, or withdrew before completing the examination ..	166	164	147	197	221
Admitted provisionally as special students ..	66	40	12	0	0
Total number of applicants for admission to freshman class	808	798	688	770	786
Per cent admitted to freshman class ..	71.3	74.4	76.9	74.4	71.9

The present policy of Harvard in admitting students can be seen from the above statistics, which are complete for the years covered

Of those admitted in the past five years there are undoubtedly some who would have been rejected if they had been compelled to come up under the new system Many of these have failed, or will fail, to complete their college course, at least with credit Of those registered, some could probably have gained admission if the new system had been open to them, and of these a large proportion would very likely have shown distinction in their subsequent college course What the effect will be upon the size of the classes admitted to Harvard College, when most of the applicants shall come up under the new system, is not easy to forecast There has been some apprehension that the percentage of boys admitted will be considerably reduced, but it is hoped that the larger number of schools which will now find themselves able to prepare boys for Harvard will counterbalance this tendency, and prevent any large reduction in the numbers of the future entering classes

V

In conclusion, a few words may be added as to the general results which it is hoped to secure from this new plan when it goes into full operation These results are of widely varying kinds

1 Harvard College hopes to secure a better body of freshmen, for they will have been selected from the whole number of applicants by more nicely adapted methods, and they will be free from conditions and therefore able to do better work.

2. A large number of excellent schools of the accepted type, now unable in their regular curriculum to fit boys to enter Harvard College, will, it is hoped, under

the new system find themselves able to do so without extra work This applies to some public schools in New England and to a large number in other parts of the country At present, there are only fourteen public high schools which have sent to Harvard College one boy a year for the past ten years, and all of these are in eastern Massachusetts.

These two results are primarily significant for the college The other desired results, if they come about, are broader in their educational significance

3. Schools of the approved type will, so far as Harvard College is concerned in the matter, gain the freedom which they require for doing their best work, since the new system will make it possible for them to concentrate their efforts by treating more thoroughly fewer subjects, or fewer topics of a subject The great need of students in schools, as well as in colleges, is that they should acquire a habit of doing well what they undertake to do, the greatest evil in education at present is that students are satisfied with mediocrity

4 The new system gives some help toward an adjustment of the problem of educating together in one school students preparing for college and students preparing for other callings. It does not wholly solve this problem, but it ought to tend somewhat to relieve it The problem itself is insoluble. Preparation for a definite vocation must be determined by the character and needs of that particular vocation, and college is a vocation for a young man of seventeen to twenty-one just as much as service in a banking house or factory, and, like those vocations, it has its own conditions of fitness. Different needs can not all be provided for under one system of education. Nevertheless, some parts of a school course are an excellent preparation both for college and for an immediate practical career, and the new system of examinations, under which requirements in specific subjects are kept as high as before but the subjects less closely defined, will, it is hoped, give as much freedom here as the nature of the case permits.

5 The new plan leads away from emphasis on single courses, and insists on the significance of the education taken as a whole In accord with this underlying idea it is free from all attempts to determine the relative value of subjects as expressed in numerical ratings In this respect it has a general educational importance, and ought to remove many causes of friction now existing between schools and colleges

JAMES HARDY ROPES
HARVARD UNIVERSITY

THE BOLYAI PRIZE II

INTEGRAL EQUATIONS

In these latter years, Hilbert has above all occupied himself with perfecting the theory of integral equations We know that the foundations of this theory were laid some years ago by Fredholm, since then the fecundity of his method and the facility with which it may be applied to all the problems of mathematical physics approve themselves each day with more luster. This is certainly one of the most remarkable discoveries ever made in mathematics, and for itself alone it would merit the very highest recompense, if to-day, however, it is not to the first inventor, but to the author of important improvements, that we have decided to award the Bolyai prize, it is because we must take into consideration not only Hilbert's works on integral equations, but the totality of his achievement, which is of importance for the most diverse branches of mathematical science and of which the other parts of this report permit us to appreciate the interest

But we can not enter upon this subject without paying homage to the immense service which Fredholm has rendered to science.

The theory of Fredholm is a generalization of the elementary properties of linear equations and determinants. This generalization may be followed up in two different ways: on the one hand, by considering a *discrete* infinity of variables connected by an infinity of linear equations, which leads to determinants of infinite order; on the other hand, by considering an unknown function $\phi(x)$ (that is to say in last analysis a *continuous* infinity of unknowns) and seeking to determine it by the aid of equations where this function figures in integrals under the sign $\int$. Upon this second way Fredholm has embarked.

Let $K(x, y)$ be a function we call the *kernel*, the integral

$$\psi(x) = \int K(x, y)\phi(y)dy,$$

taken between fixed limits, may be regarded as a transform of $\phi(x)$ by a sort of linear transformation and be represented by $S\phi(x)$.

The integral equations may then be put under the form

$$(1) \qquad a\phi(x) + \lambda S\phi(x) = f(x),$$

where $f(x)$ is a given function, the equation is said to be of the first kind if the coefficient a is null, and of the second kind if this coefficient is equal to 1.

The relation (1) should be satisfied by all the values of y comprised in the field of integration; it is therefore equivalent to a *continuous* infinity of linear equations.

Fredholm has treated the case of the equations of the second kind; the solution then may be put under the form of the quotient of two expressions analogous to determinants and which are integral functions of λ. For certain values of λ, the denominator vanishes. We then can find functions $\phi(x)$ (called *proper functions*) which satisfy the equation (1) when we replace $f(x)$ in it by 0.

The result supposes that the kernel $K(x, y)$ is limited; if it is not, we are led to consider *reiterated* kernels; if we repeat n times the linear substitution S, we obtain a substitution of the same form with a different kernel $K_n(x, y)$; if one of these reiterated kernels be limited this suffices for the method to remain applicable by means of a very simple artifice. Now this happens in a great number of cases, as Fredholm has shown. The generalization for the case where the unknown function depends upon several variables and for that where there are several unknown functions is made without difficulty.

Fredholm then applied his method to the solution of Dirichlet's problem and to that of a problem in elasticity, thus showing how we may attack all questions of mathematical physics.

Such is the part of the first inventor; what now is Hilbert's? Consider first a finite number of linear equations; if the determinant of these equations is symmetric, their first members may be regarded as the derivatives of a quadratic form, and hence results for equations of this form a series of propositions very worthy of interest and well known to geometers. The corresponding case for integral equations is that where the kernel is symmetric, that is to say, where

$$K(x, y) = K(y, x).$$

This Hilbert takes hold of. The properties of quadratic forms of a finite number of variables may be generalized so as to apply to integral equations of this symmetric form. The generalization is made by a simple passing to the limit, but this passing presented difficulties which Hilbert overcame by a method admirable in its

simplicity, certainty and generality. The developments reached are *uniformly* convergent, but this uniformity presents itself under a new form which deserves to attract attention. In the developments appears an arbitrary function $u(x)$ (or several) and the remainder of the series when n terms have been taken is less than a limit depending only upon n and independent of the arbitrary function, provided this function is subject to the inequality

$$\int u^2(x)\,dx < 1,$$

the integral being taken between suitable limits. This is an entirely new consideration which may be utilized in very different problems.

Thus Hilbert obtains in a new way certain of Fredholm's theorems, but I shall stress above all the results which are most original.

In the first place, the denominator of Fredholm's expressions is a function of λ admitting only real zeroes, and this is a generalization of the elementary theorem relative to "the equation in S." Afterward comes a formula where enter under the sign $\int$ two arbitrary functions $x(s)$ and $y(s)$ which we should consider as the generalization of the elementary formulas which permit the breaking up of a quadratic form into a sum of squares.

But I hasten to reach the question of the development of an arbitrary function proceeding according to proper functions. Is this development, the analogue of Fourier's series or of so many other series playing a principal rôle in mathematical physics, possible in the general case? The sufficient condition that a function be capable of such development is that it can be put in the form $Sg(x)$, $g(x)$ being continuous. This is the final form of the resultant as Hilbert gives it in his fifth communication. In the first he was forced to impose certain restrictions; here we must mention the name of Schmidt, who in the interval had produced a work which helped Hilbert to free himself from these restrictions. The only condition imposed upon our function is capability of being put in the form $Sg(x)$, and at first blush this would seem sufficiently complex, but in a large number of cases and, for example, if the kernel is a Green's function, it only requires that the function possess a certain number of derivatives.

Hilbert was afterward led to develop his views in the following manner: he this time considers a quadratic form with an infinite number of variables and he studies its orthogonal transformations; this is as if he wished to study the different forms of the equation of a surface of the second degree in space of an infinite number of dimensions when referred to different systems of rectangular axes. To this effect he makes what he calls the resolvent form of the given form. Let $K(x)$ be the given form, $K(\lambda, x, y)$ the resolvent form sought, it will be defined by the identity

$$K(\lambda, x, y) - \tfrac{1}{2}\lambda \Sigma_r \frac{dK(x)}{dx_r} \frac{dK(\lambda, x, y)}{dx_r} = \Sigma x_r y_r$$

When the form $K(x)$ depends only upon a finite number of variables, the resolvent form presents itself as the quotient of two determinants which are integral polynomials in λ.

Our author applies to this quotient the procedures of passing to the limit which are familiar to him; the limit of the quotient exists even when those of the numerator and of the denominator do not exist.

In the case of a finite number of variables, $K(\lambda, x, y)$ is a rational function of λ and this rational function can be broken up into simple fractions. What becomes of

this decomposition when the number of variables becomes infinite? The poles of the function rational in λ may in this case or otherwise tend toward certain limit points infinite in number but discrete.

The aggregate of these points constitutes what our author calls the *discontinuous spectrum* of his form. They may also admit as limit points all the points of one or several sects of the real axis. The aggregate of these sects constitutes the *continuous spectrum* of the form.

The simple fractions corresponding to the discontinuous spectrum will make in their totality a convergent series, those corresponding to the continuous spectrum will change at the limit into an integral of the form

$$\int \frac{\sigma d\mu}{\lambda - \mu},$$

where the variable of integration μ is varied all along the sects of the continuous spectrum, and where σ is a suitable function of μ. The rational function $K(\lambda, x, y)$, therefore, has then as limit not a meromorphic function, but a uniform function with erasures. The decomposition into simple elements thus transformed remains valid. If the given form is *limited*, that is to say, if it can not pass a certain value when the sum of the squares of the variables is less than 1, we can deduce thence a way of simplifying this form by an orthogonal transformation, analogous to the simplification of the equation of an ellipsoid by referring this surface to its axes.

Among the quadratic forms we shall distinguish those which are *properly continuous* (vollstetig), that is to say, those whose increment tends toward zero when the increments of the variables tend simultaneously toward zero in any way. Such a form does not have a continuous spectrum and hence result noteworthy simplifications in the formulas.

Other theorems on the systems of simultaneous quadratic forms, on bilinear forms, on Hermite's form, extend likewise to the case of an infinite number of variables.

There was in this theory the germ of an extension of Fredholm's method to kernels to which the analysis of the Swedish geometer was not applicable, and scholars of Hilbert should bring out this fact. However that may be, Hilbert first applied himself to extending his way of looking at integral equations to the cases where the kernel is unsymmetric. For this purpose he introduces any system of orthogonal functions, conformably to which it is possible to develop an arbitrary function by formulas analogous to that of Fourier. In place of an unknown function, he takes as unknowns the coefficients of the development of this function, an integral equation can thus be replaced by a system of a *discrete* infinity of linear equations between a *discrete* infinity of variables.

The theory of integral equations is thus attached, on the one hand, to the ideas of von Koch on infinite determinants, and, on the other hand, to the researches of Hilbert we have just analyzed and where the essential rôle is played by functions dependent upon a discrete infinity of variables.

To each kernel will correspond thus a bilinear form dependent upon an infinity of variables. If the kernel is symmetric, this bilinear form is symmetric and may be regarded as derived from a quadratic form. If the kernel satisfies the conditions stated by Fredholm, we see that this quadratic form is properly continuous and consequently does not have a continuous spectrum. This is a way of reaching Fredholm's results, and however indirect it may be, it opens entirely new views of the profound reasons for these results and hence on the possibility of new generalizations.

Integral equations lend themselves to the

solution of certain differential equations whose integrals are subject to certain conditions as to the limits, and this is a very important problem for mathematical physics. Fredholm solved it in certain particular cases and Picard generalized his methods. Hilbert made a systematic study of the question.

Consider an integral equation

$$\Delta^u = f,$$

where u is an unknown function of one or several variables, f a known function and Δ any linear differential expression. This equation with the same right as an integral equation may be considered as an infinite system of linear equations connecting a continuous infinity of variables, as a sort of linear transformation of infinite order, enabling us to pass from f to u. If we solve this equation, we find

$$u = Sf,$$

$S(f)$ this time presenting itself under the form of an integral expression.

Then Δ and S are the symbols of two linear transformations of infinite order inverse one to the other. The kernel of this integral expression $S(f)$ is what we call a *Green's function*. This function was first met in Dirichlet's problem, then it was Green's function properly so called, too familiar to be stressed, we had already obtained different generalizations of it. To have given a complete theory belongs to Hilbert. To each differential expression Δ, supposed of the second order and of elliptic type, to each system of conditions as to the limits, corresponds a Green's function. We cite the formation of the Green's functions in the case where we have only one independent variable and where they present themselves under a particularly simple form, and the discussion of the different forms the conditions as to the limits may assume. That settled, suppose we have solved the problem in the case of an auxiliary differential equation differing little from that proposed and anyhow not differing from it by the terms of the second order, we can then by a simple transformation reduce the problem to the solution of a Fredholm equation where the rôle of kernel is played by a Green's function relative to the auxiliary differential equation. However, the consideration of this auxiliary equation, the necessity of choosing it and solving it being capable of still constituting an embarrassment, in his sixth communication Hilbert frees himself from it. The differential equation is transformed into a Fredholm equation where the rôle of kernel is played by a function our author calls *parametrix*. It is subject to all the conditions defining Green's function, one alone excepted, the most troublesome, it is true, it is not constrained to satisfy a differential equation, it remains therefore in a very large measure arbitrary. The transformation undergone by the differential equation is comparable to that experienced by a system of linear equations if we replace the primitive variables by linear combinations of these variables suitably chosen. The method is nowise restricted to the case where the differential equation considered is adjoint to itself.

Hilbert examined in passing a host of questions relative to integral equations and showed the possibility of their application in domains the most varied. For example, he extended the method to the case of a system of two equations of partial derivatives of the first order of the elliptic type, to *polar* integral equations, that is to say, where the coefficient a in the integral equation (1) in place of being always equal to 1 is a function of x and in particular is equal now to $+1$, now to -1.

He has applied the method to the problem of Riemann for the formation of func-

tions of a complex variable subject to certain conditions as to the limits, to the theorem of oscillations of Klein, to the formation of fuchsian functions, and in particular to the following problem to determine λ so that the equation

$$\frac{d}{dx}\left[(x-a)(x-b)(x-c)\frac{dy}{dx}\right]+(x+\lambda)y=0$$

may be a fuchsian equation

One of the most unexpected applications is that Hilbert makes to the theory of the volumes and surfaces of Minkowski, and by which he connects with Fredholm's method a question important for those who interest themselves in the philosophic analysis of the fundamental notions of geometry

DIRICHLET'S PRINCIPLE

We know that Riemann with a stroke of the pen proved the fundamental theorems of Dirichlet's problem and conformal representation, grounding himself on what he called Dirichlet's principle, considering a certain integral depending upon an arbitrary function U, and which we shall call Dirichlet's integral, he showed that this integral can not become null and from this he concludes that it must have a minimum, and that this minimum can be reached only when the function U is harmonic This reasoning was faulty, as has since been shown, because it is not certain that the minimum can be actually reached, and if it is, that it can be for a continuous function.

Yet the results were exact; much work has been done on this question; it has been shown that Dirichlet's problem can always be solved, and it actually has been solved; it is the same with a great number of other problems of mathematical physics which formerly would have seemed attackable by Riemann's method. Here is not the place to give the long history of these researches; I shall confine myself to mentioning the final point of outcome, which is Fredholm's method

It seemed that this success had forever cast into oblivion Riemann's sketch and Dirichlet's principle itself Yet many regretted this, they knew that thus we were deprived of a powerful instrument and they could not believe that the persuasive force which in spite of all Riemann's argument retained, and which seemed to rest upon I know not what adaptation of mathematical thought to physical reality, was actually only a pure illusion due to bad habits of mind. Hilbert wished to try whether it would not be possible, with the new resources of mathematical analysis, to turn Riemann's sketch into a rigorous proof See how he arrived at it, consider the aggregate of functions U satisfying proposed conditions, choose in this aggregate an indefinite series of functions S, such that the corresponding Dirichlet integrals tend in decreasing toward their lower limit. It is not certain that at each point of the domain considered this series S is convergent, it might oscillate between certain limits But we can in S detach a partial series S_1 which is convergent at a point M_1 of the domain, in S_1, detach another partial series S_2 which shall always be convergent at M_1, but which, moreover, shall also be convergent at M_2 So continuing, we shall obtain a series which will be convergent at as many points as we wish, and by a simple artifice we from this deduce another series which will be convergent at all the points of a countable assemblage, for example at all the points whose coordinates are rational. If then we could prove that the derivatives of all the functions of the series are less in absolute value than a given limit, we might conclude immediately that the series converges uniformly in the whole domain and the application of the rules of the calculus

of variations would no longer present special difficulty

To establish the point remaining to be proved, Hilbert has used two different artifices, he has not developed the first as completely as would be desirable, and has attached himself especially to the second This consists in replacing the proposed function u by the function v, which comes from it by a double quadrature and of which it is the second derivative with regard to two independent variables The derivatives of v being the first integrals of u, we can assign them an upper limit, by the help of certain inequalities easy to prove Only it is necessary to be resigned to a new circuit and to an artifice simple however to apply to this new unknown function v the rules of the calculus of variations which apply so naturally to the function u

It is needless to insist upon the range of these discoveries which go so far beyond the special problem of Dirichlet It is not surprising that numerous investigators have entered the way opened by Hilbert We must cite Levi, Zaremba and Fubini, but I think we should signalize before all Ritz, who, breaking away a little from the common route, has created a method of numeric calculus applicable to all the problems of mathematical physics, but who in it has utilized many of the ingenious procedures created by his master Hilbert

Recently Hilbert has applied his method to the question of conformal representation. I shall not analyze this memoir in detail I shall confine myself to saying that it supplies the means of making this representation for a domain limited by an infinite number of curves or for a simply connected Riemann surface of an infinity of sheets. This therefore is a new solution of the problem of the uniformization of analytic functions

DIVERS

We have passed in review the principal research subjects where Hilbert has left his trace, those for which he shows a sort of predilection and whither he has repeatedly returned, we must mention still other problems with which he has occupied himself occasionally and without insistence I think I should confine myself to giving in chronologic order the most striking results he has obtained of this sort

Excepting the binary forms, the quadratic forms and the biquadratic ternary forms, the definite form most general of its degree can not be broken up into a sum of a finite number of squares of other forms

By elementary procedures may be found the solutions in integers of a diophantine equation of genus null

If an integral polynomial depending upon several variables and several parameters is irreducible when these parameters remain arbitrary, we may always give these parameters integral values such that the polynomial remains irreducible

Consequently there always exist equations of order n with integral coefficients and admitting a given group

The fundamental theorem of Dedekind about complex numbers with commutative multiplication may be easily proved by means of one of the fundamental lemmas of Hilbert's theory of invariants.

The diophantine equation obtained by equating to ± 1 the discriminant of an algebraic equation of degree n has always rational solutions, but save for the second and the third degrees has no integral solutions.

Among the real surfaces of the fourth order, certain forms logically conceivable are not possible; for example, there can not be any composed of twelve closed surfaces simply connected or of a single surface with eleven perforations.

CONCLUSIONS

After this recital, a long commentary would be useless We see how great has been the variety of Hilbert's researches, the importance of the problems he has attacked We shall signalize the elegance and the simplicity of the methods, the clearness of the exposition, the solicitude for absolute rigor In seeking to be perfectly rigorous one risks at times being long, and this is not to buy too dear a correctness without which mathematics would be nothing But Hilbert has known how to avoid the tedium of such diffuseness for his readers in never letting them lose from view the guiding thread which has served him to orient himself We always easily see by what chain of ideas he has been led to set himself a problem and find its solution

We realize that, more analyst than geometer in the ordinary sense of the word, he nevertheless has seen at one view the totality of his work before distinguishing details and he knows how to give his reader the advantage of this all-embracing vision

Hilbert has had a tremendous influence upon the recent progress of the mathematical sciences, not alone by his personal work, but by his teaching, by the counsel he has given to his scholars and which has enabled them to contribute in their turn to this development of our knowledge by using the methods created by their master.

There is no need, so it seems, to say more in justification of the decision of the commission which has unanimously awarded to Hilbert the Bolyai prize for the period 1905–1909.

M. Poincaré

THE WILLARD GIBBS MEDAL

In the early part of 1909 Mr. William Converse, of Chicago, proposed to the Chicago Section of the American Chemical Society to found a gold medal to be awarded annually by the Section Mr. Converse stated that the object of his proposition was to stimulate interest in the work of the Section and of the society at large and to encourage the highest ideals of the science in their members The Section gladly welcomed and accepted the offer made It was proposed to name the medal after the most eminent chemist America has given to the science, and the consent of Mrs Van Name, the surviving sister of Willard Gibbs, having been secured, the medal founded by Mr Converse was named the Willard Gibbs Medal After various plans had been suggested and discussed, the Section decided that the medal should be awarded annually, by invitation, rather than by competition and the following rules were adopted for the award.

RULES FOR THE AWARD OF THE WILLARD GIBBS MEDAL, FOUNDED BY WILLIAM A CONVERSE

1 A gold medal shall be awarded annually by the Chicago Section of the American Chemical Society at its May meeting, which meeting shall be open to the public

The medal is to be known as the Willard Gibbs Medal founded by William A Converse

The award shall be made according to the rules here set forth and made a part of the by-laws of the Chicago Section

2 The award shall be made by a two-thirds vote of a jury of twelve, to anybody who because of his eminent work in and original contributions to pure or applied chemistry, is deemed worthy of special recognition by the jury

3. A condition of the award shall be that the recipient of the medal shall deliver an address upon a chemical subject of his own selection and satisfactory to the jury at the May meeting of the Chicago Section of the American Chemical Society. He shall be notified of the award three months in advance of this meeting by the chairman of the Chicago Section.

4. The jury of the award, to be known as the Jury of the Willard Gibbs Medal, shall consist of twelve members, six of them to be members of the Chicago Section. The chairman of the Chicago Section shall be chairman of the jury, but shall have no vote.

5. Four members of the jury shall be elected each year to serve three years, in the same manner

and at the same time as the officers of the Chicago Section

At the first election of the jurors of the Willard Gibbs Medal, to be held in 1911, four jurors shall be elected to serve a term of one year, four to serve a term of two years and four to serve a term of three years. Of each four elected, two shall be from the Chicago Section

6 At the call of the chairman of the Chicago Section the jury shall begin its deliberation on January 2 of each year

Each member of the jury shall be entitled to place in nomination the names of two candidates The voting shall then be on these candidates

The four names receiving the highest number of votes on the first ballot shall be retained, the others rejected

If of the four names retained, none receives a two thirds vote on the second ballot, the two receiving the fewest votes shall be dropped. If on further balloting the committee finds it impossible to make a selection by a two thirds vote, it will report to the section, which will proceed to elect the recipient of the medal, but if any candidate receives a two thirds vote of the committee, his election shall be final and shall be so reported to the section

7. It is desired that the paper or address, if suitable, be published in one of the publications of the American Chemical Society.

8 The executive committee of the Chicago Section shall have the power to decide any question not specifically covered by these rules

9. The Chicago Section shall have the power to change or amend these rules in the same manner as the by-laws of the section

For the first year of the foundation, 1911, by special amendment of the rules of the Section a special jury of award was elected, consisting of the following members S A Mather, chairman of the section and president of the Thorkildsen-Mather Co, W. Brady, chief chemist of the Illinois Steel Co.; D K French, secretary of the section and chemist of the Dearborn Drug and Chemical Co.; W. Hoskins, of Mariner and Hoskins, Professor John H. Long, of the Northwestern University Medical School; A. Lowenstein, chief chemist of Nelson Morris & Co.; Professor H. McCormick, of Armour Institute; Professor H. N. McCoy, of the University of Chicago; W D. Richardson, chief chemist of Swift & Co; Professor Alexander Smith, of the University of Chicago, and president of the American Chemical Society, and Professor Julius Stieglitz, of the University of Chicago By a unanimous vote the jury decided to award the first medal to Professor Svante Arrhenius for his fundamental work on the theory of electrolytic dissociation

The medal was presented to Dr. Arrhenius on the evening of May 12, after a banquet which was attended by over 200 members and guests of the section The formal program of the evening included the following addresses "International Bonds of Science," by Harry Pratt Judson, president of the University of Chicago, "Chemistry and Commerce," by Mr Wheeler, president of the Association of Commerce of Chicago, "The Willard Gibbs Medal," by S A Mather, chairman of the Chicago Section of the American Chemical Society, "The Presentation of the Willard Gibbs Medal to Dr Arrhenius," by Alexander Smith, president of the American Chemical Society, and "The Willard Gibbs Address," by the medallist, Svante Arrhenius, on "The Theory of Electrolytic Dissociation." The last address gave, in outline, the history of the discovery of the theory of electrolytic dissociation, it formed, on the one hand, an intensely interesting record of the birth of a great idea and theory, of its early difficulties and its final triumph; and, on the other hand, it presented a picture of the struggles, progress and development of the genial discoverer of the theory

The address will be published under the auspices of the Chicago Section of the American Chemical Society

SCIENTIFIC NOTES AND NEWS

DR. SAMUEL H. SCUDDER, of Cambridge, eminent for his contributions to entomology, especially lepidoptera and fossil insects, died on May 17, aged seventy-four years.

DURING his recent visit to Washington at the time of the annual meeting of the National Academy of Sciences, Sir John Murray presented a fund of six thousand dollars to

the academy for the purpose of founding an Alexander Agassiz gold medal which shall be awarded to scientific men in any part of the world for original contributions to the science of oceanography.

AT the twentieth annual commencement of Stanford University, to be held from May 17 to 22, a portrait of President Jordan will be presented to the university.

COLONEL WILLIAM GORGAS, U. S. A., head of the sanitary forces on the Isthmus of Panama, received the honorary degree of doctor of laws from Tulane University at its annual commencement on May 17.

PROFESSOR PAUL H. HANUS, head of the department of education at Harvard University, has been chosen to take general charge of the investigation of the New York public school administration conducted by the School Inquiry Committee.

PROFESSOR C. F. MABERY has resigned the professorship of chemistry in Case School of Applied Science, which he has occupied since 1883.

DR. J. REIN, professor of geography at Bonn, has celebrated the fiftieth anniversary of his doctorate.

DR. R. FICK, professor of anatomy at Innsbruck, has been elected a corresponding member of the Royal Society of Physicians of Vienna.

THE Pharmaceutical Society has elected the following honorary members: Professor W. E. Dixon, F.R.S., professor of pharmacology, King's College, London; Dr. Adolph Engler, director, Botanical Museum, Berlin; Professor Percy F. Frankland, F.R.S.; M. Eugène Léger, pharmacien en chef de l'Hôpital St. Louis, Paris; Lieutenant-Colonel D. Prain, F.R.S., director of Royal Gardens, Kew; and Dr. Ludwig Radlkofer, professor of botany, University of Munich.

THE *Bulletin* of the American Mathematical Society states that the eminent mathematician, Professor Gaston Darboux, of the University of Paris, being about to complete his fiftieth year of service as a teacher in the system of public instruction of France, it is proposed by a large international group of his mathematical co-workers, friends and former pupils to commemorate this anniversary by presenting to Professor Darboux a gold medal bearing his portrait, and an appropriate address signed by the participants. All mathematicians are invited to share in rendering this honor to Professor Darboux. Copies of the medal, in reduced size, will be struck. Subscribers of twenty-five francs will receive a copy in bronze, subscribers of fifty francs a copy in silver. Subscriptions should be sent to Professor Cl. Guichard, secretary of the Faculté des Sciences.

DR. JOHANNES HARTMANN, professor of astronomy at Gottingen and director of the university observatory, has been called to be director of the Argentine Observatory at La Plata.

PROFESSOR C. H. HITCHCOCK, emeritus professor of geology at Dartmouth College, has come east from Hawaii for the purpose of completing his field work for the Geological Survey of Vermont. Some attention will also be paid by him to ichnological studies. His address will be at Hanover, N. H., for the summer.

PROFESSOR ALEXANDER GRAHAM BELL returned on May 8 from a trip around the world.

DR. T. C. MENDENHALL, formerly of the Ohio State University and later president of Worcester Polytechnic Institute, is on a visit to Japan, where from 1878 to 1881 he occupied the chair of physics in Tokyo University.

DR. JOHN C. BRANNER, of Stanford University, is the head of a scientific expedition to the coast of Brazil, which sailed from New York on April 18 for Para.

MR. WILFRED H. OSGOOD, of the Field Museum of Natural History, has returned from three months work in Venezuela and Columbia, having obtained important collections of birds and mammals, including a small series of the rare marsupial, *Cænolestes*, a living representative of the family Epanorthidæ.

WE learn from the *Auk* that Mr A C Bent, of Taunton, Mass, is organizing an expedition to the Aleutian Islands for the purpose of making a thorough biological survey of that interesting region, covering practically the whole of the summer season Negotiations are now on foot to secure the use of a revenue cutter to take the party, which will consist of three scientific men in addition to Mr Bent Mr Rollo H Beck, known for his work in the Galapagos Islands and along the coast of California, has already been engaged, and it is probable that the United States National Museum and the Biological Survey will each send a representative

PROFESSOR W F. WATSON, who has held since 1890 the chair of chemistry and biology at Furman University, Greenville, S C, has resigned, and will spend four years in a tour around the world.

DR. SVANTE ARRHENIUS lectured at the College of the City of New York on May 17 and at Columbia University on May 18 On May 15 he lectured on the J C Campbell foundation of the Sigma Xi Society of the Ohio State University

DR WALTER B CANNON, professor of physiology in the Harvard Medical School, will give the annual address before the graduating class of the Yale Medical School at the approaching commencement

PROFESSOR JOHN M. COULTER, head of the department of botany of the University of Chicago, will give an address before a joint meeting of the Sigma Xi and Phi Beta Kappa fraternities on June 12, as a part of the program of commencement week at the University of Illinois.

PROFESSOR W. W. OSTERHOUT addressed the Biological Society of Smith College on May 18 on "Some Aspects of the Action of Mineral Salts on Plants"

DR. E. E BARNARD, of Yerkes Observatory, lectured on "Photographic Revelations in Astronomy" before the Dayton Astronomical Society on May 10 and before the Cincinnati Astronomical Society on May 12.

AT the first annual meeting of the Cincinnati Society, held May 12, the following officers were elected Dr Lisle Stewart, president, W C Cooder, vice-president, Robert H Correy, secretary, A D Fisher, treasurer, A D Alcorn, P B Evens, J D Griese, A P. Henkel, C H Norton, M C Slutes, directors President Taft was unanimously elected an honorary member Sixty-five men and women joined as charter members This society expects to interest itself particularly with astronomical and astrophysical research

WE learn from *Nature* that a committee of the Geological Society, London, has been formed to secure the means of providing a memorial to the late Professor T Rupert Jones, F R S, in aid of his widow and daughters The late Professor Jones was never in receipt of more than a very moderate income, and received only a small pension upon his retirement thirty years ago from the post of professor of geology in the Royal Military College, Sandhurst.

THE ninety-fourth annual meeting of the Swiss Scientific Society, will be held this year at Solothurn, from July 30 to August 2, under the presidency of Dr A Pfaehler In addition to the general sessions for which a number of addresses of general interest are arranged, there meet with the association the Swiss societies for botany, chemistry, geology, mathematics, physics and zoology Foreign men of science are especially invited to be present at the meetings

THE H F. KIETH COMPANY, of Boston, have given $5,000 to the Massachusetts Institute of Technology, for a research on the decomposition and general wholesomeness of eggs and for an investigation of the bacterial and chemical contents of the product under varying conditions

Two collections of birds have been placed on deposit in the American Museum of Natural History. One of these, the property of Dr. Jonathan Dwight, Jr., of New York City, numbers about 30,000 specimens, ranking as one of the largest private collections in this country. It is especially valuable in showing

plumages and molts of North American species. The second collection belonging to Dr. Leonard C. Sanford, of New Haven, Connecticut, contains about 400 specimens, largely non-passerine birds, and includes rare species especially among the albatrosses and petrels, some of which are not represented in the American Museum collections.

AN arrangement has been concluded between the German and English governments and the Marconi Company by which the weather observations transmitted by wireless telegraphy from ships on the Atlantic will be made mutually available to the English and German Meteorological Offices. Experiments in this direction were made in 1909. The new arrangement is expected to come into force by next year at latest. The observations will be transmitted to the Meteorological Office in London, to the Marine Observatory at Hamburg and to the Meteorological Station at Aachen.

IN Bulletin 420 of the United States Geological Survey, entitled "Economic Geology of the Feldspar Deposits of the United States," by Edson S. Bastin, there are descriptions of the many feldspar deposits in the country and the extent to which the industry has grown. The principal consumers of feldspar are manufacturers of pottery, enamel ware, enamel brick and electric ware. The trade demands that feldspar for use in pottery be nearly free from iron-bearing minerals (biotite, garnet, hornblende, black tourmaline, etc.) and that it contain little if any muscovite. Feldspar is also used in the manufacture of emery and carborundum wheels, as a flux to bind the abrading particles together. Small quantities of feldspar are used in the manufacture of opalescent glass and carefully selected pure feldspar is used in the manufacture of artificial teeth. Some is used in scouring soaps and window washes, the fact that feldspar is slightly softer than glass rendering these soaps less liable to scratch windows or glassware than the soaps in which quartz is the abrasive substance. Two firms in New York and one in Connecticut crush feldspar for poultry grit and for use in the manufacture of ready roofing. In a number of the feldspar quarries garnets, green tourmalines and aquamarines (beryl) of gem quality are found, but seldom in such quantity as to warrant mining for the gems alone. Mr. Bastin mentions a feldspar quarry in Connecticut where some of the cavities that yielded gem tourmalines were as large as a bushel basket. At another quarry in the state a large transparent green tourmaline about seven inches long was found. This stone is now in the museum of the Wesleyan University at Middletown, Conn. One pocket in the same quarry contained a large crystal weighing several pounds, of pale-blue to pale-green color, the tints being similar to those observed in some aquamarines. Unfortunately, this crystal was much shattered in the blasting, but the fragments have yielded a number of small cut gems of great beauty.

UNIVERSITY AND EDUCATIONAL NEWS

GOVERNOR FOSS has signed the bill by which the Massachusetts Institute of Technology will receive \$100,000 annually from the state for ten years. By the terms of the measure the Institute will maintain 80 free scholarships to be apportioned among the 40 senatorial districts of the state.

THE California legislature has passed a bill which has been recently signed by the governor appropriating \$25,000 for a soils laboratory building, equipment and other improvements at the Citrus Experiment Station. About \$1,500 of this amount will be used in improving the irrigation system, \$2,500 to complete the title for building site and nursery grounds, about \$2,000 for incidentals, leaving \$19,000 for building and equipment. The work of this laboratory is to be confined to the study of citrus soils from their chemical, physical and biological phases.

THE legislature of Hawaii, just adjourned, appropriated \$75,000 for a new building for the College of Hawaii and \$20,000 for maintenance expenses. The committee of education favored the adoption of the plans that have been drawn up for the development and

embellishment of the campus and grounds These grounds are located in Manoa, a suburban valley with both mountain and sea views, and comprise about ninety acres Sixty acres were purchased and thirty acres were set aside by the government The total grounds with its water has a market value of about $125,000

M ALBERT KAHN, of Paris, who has established traveling fellowships in several foreign countries, has given $2,500 for such a fellowship in the United States It is expected that the fellow selected will travel around the world giving a year to the trip Selection of the fellow will be made by the trustees, who are Edward D Adams, Nicholas Murray Butler, Charles W Eliot, Henry Fairfield Osborn and Charles D Walcott, and they are to choose preferably professors in isolated southern and western institutions

DR H. Y BENEDICT, professor of applied mathematics and director of the department of extension of the University of Texas, has been made dean of the College of Arts

AT the University of Pennsylvania Dr Richard M Pearce has been transferred from the chair of pathology to that of experimental pathology, and Dr Allen J Smith has been transferred from the chair of tropical diseases to that of pathology, formerly occupied by him.

DR. LUTHER WILLIAM BAHNEY, assistant professor of metallurgy at Leland Stanford University, has been appointed assistant professor of mining and metallurgy in the Sheffield Scientific School, Yale University

DR. CLARENCE A. PIERCE, of Cornell University, has been appointed assistant professor of theoretical electrical engineering at the Worcester Polytechnic Institute to succeed Dr. George R. Olshausen, who has resigned after four years of service

DR. WALTER S. TOWER, assistant professor of geography in the University of Pensylvania, has been called to the University of Chicago.

DR. J. FRANK DANIEL has been promoted to be assistant professor of zoology in the University of California.

DISCUSSION AND CORRESPONDENCE

THE LAW THAT INHERES IN NOMENCLATURE

DR. JORDAN'S answer[1] to my inquiry,[2] "Whether there is not a better way of disposing of our nomeclatural trouble than first making it as burdensome as possible and then making it permanent?" is, if I understand him aright, that, alas, there is none, at least, there is none yet in sight, or likely to appear. Hence it were better to take up the burden cheerfully, and begin getting used to it

Whether one be pleased with this prospect or not, he must be grateful for Dr Jordan's clear and forceful statement of certain guiding principles. This, for example, seems to me to go to the heart of the matter under discussion

"A writer dealing with scientific names must either call an animal or plant what he pleases, or else he must conform to regulations inherent in the nature of his work Arbitrary rules will soon be disregarded The necessary regulations are those which future workers will approve, and we who are working in the infancy of taxonomy must lay foundations on which the future can build" With this we may all agree, though we may hold somewhat different views as to what is the law that inheres in the nature of our work, and as to what rules are arbitrary

Surely no argument is needed against a return to the loose nomenclatural methods of the past I protest against the implication that I have advocated anything of the sort. On the contrary, I have advocated the strictest application of the laws that have been evolved by our past nomenclatural experience. I would accept a list of names exactly as furnished by the best historical knowledge that could be brought into service in producing it. And then, because such a system would be more than human nature can bear, more than language can use, and more than our science can make its best progress under, I would provide for general use a terminology giving expression to the same system in simpler form, with fewer, briefer and simpler names, and

[1] SCIENCE, March 10, 1911.
[2] SCIENCE, September 2, 1910.

symbols. That is the whole of it. No plan for solving zoological problems by rule is proposed, only a plan for conserving time and energy, offered in the belief that the purely clerical work of biological science might be accomplished with less waste. The simpler system would stand in the same relation to the existing system as that in which the Linnæan names have stood to the long descriptive phrases that preceded them.

To be sure, this plan, which allows choice of names (one out of a score more or less in every group), does not necessitate that the oldest one shall be forced into general use in the new system: rather, it leaves the selection to those most competent, most interested and most responsible for the future in each group. This feature may hold the derogation of democracy to which Dr. Jordan refers, but if so, I do not understand what sort of a democracy systematic zoology is considered to be. Is a law of priority its only possible standard of equality? I profess to be a democrat, and, in a very small way, a systematist, yet I confess I never heard of anything like this. May not this democracy abide the recognition of merit? Is it already irrevocably bound up with a statute of nomenclatural primogeniture? Does the determination of priority in and of itself necessitate that all good democrats must acclaim the restoration of lost names to the places they once transiently occupied in spite of all that may have happened in the intervening years?

I have myself long pursued priority in the hope of names that would be both stable and usable. I have even advocated the forcing of prior forgotten names back into general nomenclature. I did so as long as mere temporary convenience seemed at stake. I did so while names doubled in length, trebled in absurdity and quadrupled in number. I did so until family names began to fall and to be set up again in exchanged places. I did so until I became unable to read the literature in several groups of which I had once been a student, or to converse with modern students of those groups. I did so until it became well nigh impossible for me to give to my classes intelligible references to the literature they most needed to consult in their work.[3] And

[3] Recently, while providing tables for the work of a small class in limnology, I encountered the following situation in aquatic diptera. Half of the names of dipterous families containing aquatic larvæ have been victims of the rule of priority. Here are the names of the families of our fauna, as found in all the text books, manuals, monographs and general reference books:

Psychodidæ	* Leptidæ
* Ptychopteridæ	Empididæ
Tipulidæ	x * Stratiomyiidæ
x * Blepharoceridæ	Syrphidæ
Dixidæ	* Borboridæ
* Chironomidæ	Ephydridæ
Culicidæ	x * Cordyluridæ or
* Simuliidæ	* Scatophagidæ
Tabanidæ	Sciomyzidæ

Only those unmarked in the list remain unchanged. Of the others, three (marked x) have been changed in spelling only, return to an incorrect or inelegant form being required in this line of progress. One of these names, Cordyluridæ, is in less common use than Scatophagidæ, but Scatophaga also falls. In addition to this, the well known names *Syrphus* and *Sciomyza* have been shifted to designate new groups of species in their respective families. So, also, has *Corethra* within its subfamily. All these familiar groups will now bear unfamiliar names.

Now, perhaps, a better democrat than I would have adopted all these changes willingly and pursued priority to the bitter end. But I did not. I wished my class to use the literature that has grown up about the names *Corethra, Chironomus, Simulium, Eristalis*, etc., names that are the subjects of books, of memoirs and of classic investigations in many fields of biology, and that have nowhere any uncertain meaning. As a teacher I could not afford the time and effort necessary to explain to rational young people why the "interests of taxonomy" require that *Corethra* or *Syrphus* be removed from their accustomed places after one hundred years, and used to designate entirely different groups of flies. In fact, I can not explain this; nor why, if the zoologists of the world have been able to agree on a law of priority, they might not yet be able to agree upon something less distressing.

Any one who speaks of this as a matter of *temporary* inconvenience surely is thinking in terms of geologic time.

then I began to entertain doubts as to the approval of posterity, the best kind of foundations, etc I began to lose faith in the law of priority as a cure-all for nomenclatural ills For the real burden of nomenclature will be but little altered by the strictest application of this law At worst (and surely the worst is now in sight) it will have added but a little dead weight of stupid and unnecessary confusion—so little, indeed, it would hardly be noticeable were not the load already at the endurance limit With all the arduous labor now required of any youth for gaining even an elemental conception of the world's accumulated store of knowledge, why should any man, even though a profound scholar, familiar with the intricacies of his own field, so far forget or minimize the difficulties of the long way by which he has come as to be willing to leave the path harder for the next comer. Ought not the way that leads to a working knowledge of plants and animals to be as easy and plain as we can possibly make it? I think so And so thinking, I ventured to propose, after long consideration, the simplification that is now under discussion

My plan would accept the facts of nature as they are—exceedingly complicated They are not more complex under one system than under another And it is a great error to assume that because facts are numerous and relations complex, the method of handling them must be equally so

My plan would accept human nature as it is—exceedingly prone to differences of opinion, yet, withal, able often to agree upon such matters as dates of publication.

My plan would accept the results of the application of the law of priority *in toto*, conserving all the good work that has been done by the zoologists of the world in their search of early literature. It would keep the results of this work forever accessible, without making of its by-products stumbling blocks in the way of beginners, of general students, and of the increasing thousands who may have an interest in biological sciences This work is of great historic value It is worth while to have all the old and unused names set in their proper order and sequence But to have any such of them as have lain buried during the growth of a great literature, used when exhumed to replace the names about which that literature has grown, making its treasures less accessible, is a lamentable abuse of the historic method[4] Let us accept the good work that has been done in determining priority at its historical value, and then let us use it like rational beings for our assistance, without making it a source of embarrassment for future generations

My plan would accept the Linnæan system as it is, recognizing species as real entities that have received and that will continue to receive names Were Linnæus resurrected today, he might have difficulty in recognizing his own system, in its present dropsical condition Those who value it so highly should at least remember that, whatever it has become, it was in the beginning simply and solely an effort at simplification of nomenclature

The matter of numbering species is so simple it is hard to understand how any difficulty is found in applying it Given a list of the names now recognized in any group written down in their original form and in their historic sequence, any common clerk could affix the numerals correctly. Their stability would be assured by the only means whereby anything becomes stable—by adoption and use Any one who will read my proposal with reasonable care will see (1) that it accepts every name exactly as given by its author, and finds a place for it in its proper sequence; (2) that it matters not at all where we begin numbering, and (3) that it matters not at all whether *Balanoglossus* and the tunicates are fishes or not.

I regret Dr. Jordan did not see these things, for then he might have saved space for a statement of the inherent law of nomenclature. Formulation of it is badly needed.

[4] My proposal, however, was to let the principal workers in any group decide upon the names to be used in it. If those who study lancelets do not wish to use the name *Amphioxus*, neither do I wish to use it.

Elsewhere real progress is found in the direction of simplification, which makes for convenience, saves time, and meets the limitations of memory by instituting more concise methods of making records. Does the law that inheres in nomenclature differ so much from that which obtains in all other vast accumulations of facts? If so, let us have a statement of it, so that we may, by understanding it, attain to acquiescence in the inevitable.

JAMES G. NEEDHAM
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ON EVIDENCE OF SOMA INFLUENCE ON OFFSPRING FROM ENGRAFTED OVARIAN TISSUE

TO THE EDITOR OF SCIENCE: In publication No. 144 of the Carnegie Institution of Washington entitled, "On Germinal Transplantation in Vertebrates," by Castle and Phillips, issued March 14, 1911, an attempt is made to overthrow my experiments on transplantation of ovaries in fowls,[1] and Magnus's[2] experiments of similar character on rabbits, and to establish a claim to priority in the demonstration that offspring may result from transplanted ovaries; and the effect, if any, of soma influence on such offspring. Therefore, I feel it incumbent to call attention briefly to certain of the statements in order that no misunderstanding may result. Since my papers with the experiments are readily available, I shall avoid all unnecessary repetition.

In a word, the situation is as follows: By exchanging the ovaries of fowls and breeding the fowls, I obtained results which seem to show that the transplanted ovaries preserved their reproductive function, and the resulting offspring presented evidence of soma or foster-mother influence. The results are given in detail in my several papers. I may add that since I had no allegiance with any school of theorists, I was not involuntarily partial in observing and recording the results. Whether the results would substantiate either or neither of the theories built largely upon speculation as to the relationship of reproductive tissues to their environment, or whether the character of the offspring would conform to Mendel's results of studies of inheritance in peas, gave me no concern.

The primary object of the experiments was to determine if an engrafted ovary might retain its reproductive function. Therefore, an answer to the question was obtained. And incidentally information on soma influence was secured. Following this, it seemed of additional interest to reverse the matings of the parent stock. And also, by breeding, to study the character of the offspring from the offspring obtained from engrafted ovaries. Unfortunately before this was accomplished, the experiments were terminated by an outbreak of disease among the fowls. But I did not consider then, nor have I since come to believe, that the character of the offspring of the second generation could do more than indicate whether or not soma influence might be evident in the character of the offspring of this generation, that is, the grand chicks. But owing to a degree of familiarity with the general principles of physiological experimentation and interpretation, from the beginning I saw the limitations to the absoluteness of any evidence that might be obtained by continuation of such experiments. For example, before drawing the provisional conclusions in the announcement of my results, the statement was made that "more data must be had on these points before definite conclusions can be drawn."[3] Apparently Castle has

[1] "Results of Removal and Transplantation of Ovaries in Chickens," presented before the American Physiological Society in connection with the seventh meeting of the Congress of American Physicians and Surgeons, Washington, D. C., May 7–9, 1907 (*American Journal of Physiology*, 1907, XIX., xvi–xvii). "Further Results of Transplantation of Ovaries in Chickens," *Journal of Experimental Zoology*, 1908, V., 563. "On Graft Hybrids," presented before the American Breeders' Association, Omaha, December, 1909. "Survival of Engrafted Tissues. I. (A) Ovaries and (B) Testicles," *Journal of Experimental Medicine*, 1910, XII., 269.

[2] Magnus, "Transplantation af Ovarier med Saerligt Hensyn til Afkommet," *Norsk Magazin for Laegevidenskaben*, 1907, No. 9.

[3] *Journal of Experimental Zoology*, June, 1908, V., p. [illegible].

overlooked this statement. And I may say that all subsequent statements regarding my results have been made from the same standpoint.

In attempting to interpret my results from the Mendelian standpoint, to overcome the difficulty in concluding that in no instance the offspring were derived from engrafted ovarian tissue, Castle can only see his way clear by speculating as to the result that might have followed had I employed two white cocks in the matings, one cock being a half-breed. But he assumes that only one white cock was used, for, as he points out, I use the expression "*the* white rooster." But since a point of doubt has been raised as to whether one or more white cocks were employed, and since Castle claims that I make no specific statement on this point, I would refer to the table on page 565 of the paper appearing in the *Journal of Experimental Zoology*, which is headed "weights of the chickens were as follows," in which the experiment numbers of the individuals, both male and female, used in the experiment are given, together with their weights.

In respect to the evidence of soma influence, this was observed in the offspring directly from the transplanted ovaries. Therefore, it is not open to the same doubt as in the case of more indirect or circumstantial evidence. But supposing that such offspring had been bred, and supposing the offspring resulting from this mating (grand chicks) had or had not presented characteristics indistinguishable from the offspring obtained by straight breeding or of hybrids obtained by crossing unoperated fowls of the breeds employed, such results could not affect the conclusions of foster-mother influence in the first generation. It would only show that in the particular individuals presenting feather markings indicating soma influence, that similar feather markings were or were not transmitted to their offspring, or that individuals presenting no such markings might or might not transmit evidence of soma influence to the next generation. Again, the fact that the markings in all cases were not uniform in the offspring of the first generation, in no way invalidates the results. For all exact knowledge of soma influence must of necessity spring directly from experimental results. Therefore, it can not be assumed that all such offspring must present similar characters either to be acceptable as evidence that an engrafted ovary may preserve its reproductive function, or that such offspring may be influenced by the somatic tissues of the host. That is to say, it is not permissible to assume that all of such offspring would be influenced in the same direction or to the same degree. Nor can it be assumed that evidence of soma influence can be demonstrated in other combinations of fowls, much less in different species of animals.

Seemingly a lack of insight into the underlying physiological principles in such experimentation has led Castle and his collaborator into a misunderstanding, and therefore into stating their belief that my interpretation of the results, and my criticism of a statement of theirs regarding evidence of soma influence,[4] was due to a failure to grasp fully the laws of inheritance of the character which I used as a criterion. But this is more of a personal matter and therefore of no general interest.

These writers call attention to the fact that Davenport attempted to repeat my experiments on fowls, with the result that in every case spaying was incomplete, and the young from such operated hens showed no influence of the introduced graft. This is far from being an argument against the acceptance of my conclusions, as all that it shows from his interpretation is that the ovaries were incompletely removed in his experiments. But as a matter of fact, his experiments and results, while meagerly reported,[5] such as they are, might as well lead to the conclusion that he obtained very strong evidence of soma influence. That is, the chicks so closely re-

[4] "Guinea-pig Graft-hybrids," SCIENCE, N. S., 1909, XXX., 724.

[5] Davenport, "Inheritance of Plumage Color in Poultry," *Proceedings of the Society for Experimental Biology and Medicine*, 1910, VII., 168.

sembled the foster mother that he was led to ascribe the result to original ovarian tissue of the foster mother This assumption was based upon another assumption, namely, that chicks from the engrafted ovaries would preserve the characters of the fowl from which the ovaries were obtained The fallacy of this assumption has been pointed out above

Davenport did not use standard varieties of fowls, so far as I am able to determine from his statements This is unfortunate, as it is obviously impossible to discuss his findings from the standpoint of relationship of donor to host For example, I have shown that engrafted ovaries in fowls do not succeed if the stock is too distantly related

Davenport states that my results justify the opposite conclusions to those which I have drawn, but since he does not give any reasons nor present any evidence for such a conclusion, it carries no weight other than as a personal opinion

Castle and Phillips ask that my experiments be repeated before they accept my interpretation of the results In reply, I ask why they did not employ fowls (chickens) in order to confirm or discredit my experiments I may say that my first series of fowls, operated on in the summer of 1904, were all lost through lack of proper facilities The next series, operated on in 1906, were given my undivided attention and furnished the material for my papers. A larger series operated on the following year with the view of extending the observations and investigating new fields opened up by the successful series, were not productive of results in the direction of permitting the study of offspring from engrafted ovaries, but furnished considerable information along other lines which is in part presented in my later papers. Successful breeding of fowls, as every one knows, demands the fulfillment of certain requirements in the way of quarters, and facilities for hatching and raising the chicks, and intelligent attention. As to the first two of these requirements, the third series of experiments clearly proves that the quarters and facilities at my disposal, though after a manner adequate for eight fowls, the number composing the second series of experiments, were not adequate for five times this number, the approximate number that were included in the third series. Also, it was not possible for me to give as much time to the third series as to the second Immediately following this, I made application to the officers of one of the endowed research funds for support in prosecuting the investigation on a much larger scale, which included the employment of a number of species of animals But for perfectly good reasons the request was denied Since that time new experiments have been continuously in progress, but they have been designed with a view of keeping within the limits of my facilities

I do not propose to enter into a discussion of Castle and Phillips's results in this place, save to challenge their assertion that theirs is the first critical case of successful ovarian transplantation from the standpoint discussed above, on record This statement I make in view of the fundamental considerations also above stated, as well as from an examination of their protocols For example, they used mongrel stock Therefore, any evidence furnished by the character of the offspring would be of doubtful value This is true particularly as regards soma influence, and as crossbreeding was not employed, any evidence of soma influence in the offspring would have been obscured by the character of the male parent

Also it is not proven that the offspring may not have come from ovarian tissue of the host left in site after operation Indeed, an interpretation of their results from the numerical standpoint, a criterion employed by them in interpreting their results from the Mendelian standpoint, it would be as fair to conclude that in all of their pigs that became pregnant no post-mortem findings are given. And after operation that this was due to incomplete removal of ovarian tissue For they state that of the five animals in this group, the results in three were due to ovarian tissues generated from the host. Of the two animals left in the successful group, for one

denying soma influence, the results in this case might as well lead to the conclusion that the offspring were from ovarian tissue of the mother, as from the engrafted ovarian tissue. Also in the remaining animal, from the description given of the post-mortem findings it is impossible to conclude that the mother's ovarian tissue was completely removed on both sides. This objection the authors endeavor to surmount by stating that the mass of ovarian tissue found at the site from which the right ovary was removed, was apparently strongly encapsulated, so that no ovum could be discharged even if it came to maturity. Such a conclusion is of course incompatible with the evidence, for few experienced pathologists, from the evidence presented, would care to make such a definite statement as to the retention of liberated ova.

Similarly, their statements regarding the regeneration of ovarian tissue are too absolute. For example, in certain cases where both ovaries were removed and ovaries from another animal engrafted in the neighborhood, as to the horn of the uterus, the absence of ovarian tissue at the site of implantation, and the presence of ovarian tissue at the site of removal of the animal's own ovaries is not proof that the former degenerated, and the latter regenerated. For it is possible that the implanted ovaries might have come in contact with the raw surface left after removal of the original ovaries, and become attached thereto. And since the engrafted ovaries were secured in place by means of exceedingly fine strands of unraveled silk, it is by no means certain that they could not have broken away from their moorings, owing to a cutting out of the tissues or a slipping of the knots, or even a breaking of the thread, though the latter accident would probably be less liable to occur.

These are merely some points that it is unsafe to leave out of account in concluding that such experiments are critical in the absolute sense, and I wish to say that I do not urge them as invalidating their results. In fact I consider that they have added at least one more confirmatory observation upon the reproductive functioning of transplantated ovaries, probably two, and possibly five. For the evidence does not absolutely rule out the animals which they have placed in the group in which they think regeneration of the ovarian tissue occurred. But it should not be forgotten that conclusions based upon indirect evidence, though appearing absolute, are never wholly free from at least a shadow of doubt. To accept this statement, it is only necessary to trace almost any biological subject developed from indirect experimentation a little way back into the literature. Indeed, teachings based upon such conclusions have passed without question through generations, to be later overthrown. And since the element of indirectness has not been eliminated in the experimental investigation of ovarian transplantation, I have stated that my results *seem* to lead to certain conclusions. And the same applies to Castle and Phillips's results as regards functioning of engrafted ovaries.

As to their interpretation of the results from the Mendelian standpoint, the nature of some objections to their conclusions has been discussed above. In addition, I would say that it is unfortunate that they did not preserve the individuals furnishing an ovary for engrafting, leaving the other ovary in place and then breeding this female to the same male used upon the female carrying the engrafted ovary. From their paper it would seem that they look chiefly to the second generation for evidence of soma influence, the index for detecting such influence being based upon the assumption that such influence would show in the second generation. The fallacy of this assumption has also been considered above.

In conclusion, I desire to say that the continuation and extension of these experiments is of the greatest interest and importance, and I hope that Professor Castle and his pupil may see their way clear to continuing them on a larger scale, using purer varieties of animals, including fowls of not too distantly related varieties.

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SCIENTIFIC BOOKS

Electric Motors By H. M. HOBART London, Whitaker & Co. 1910.

The name of Hobart is so well known to designing engineers in the electrical engineering field that any work from his pen needs no introduction to members of that profession. The volume under consideration being the second edition of his "Electric Motors" of 1904 is not altogether new to the electrical engineering fraternity, but there has been a considerable revision and modernization of the subject and an increase in the size of the book The large amount of data included has also been revised to correspond to recent practise

The scope of the book includes the electrical design, predetermination of characteristics, testing, operation and methods of special application of practically all types of motors now in commercial use, including the interpole D.C. motor and the single-phase series and repulsion A.C motors

Mr. Hobart's method of treatment is largely empirical and practical and each procedure is premised by copious data taken from tests

It assumes a knowledge of the fundamental principles and familiarity with design. Thus it will serve better as a reference book for engineers and instructors than as a text-book for the student in technical schools

No general method is given for the preliminary selection of dimensions for a design, but the reader is left to consult the data given. This is a common custom among designing engineers who, from their long experience and memory, can guess at the right proportions the first time, whereas the general practitioner or student needs some criterion for his selection. Few books on design lead up to the preliminary choice of design and dimensions by a discussion of those fundamental conditions which bear upon these proportions; such as allowable peripheral speed, allowable ampere conductors per inch or ampere stream on the armature and reasonable magnetic densities.

The book contains a very valuable compilation of data on various designs, the product of several different European manufacturers. This will make it a useful reference book for the American engineer, as it gives him information on the methods which others, having a different view-point, have used to solve those problems which he has met and probably solved in his own way But it will be regretted by the general practitioner and the novice in designing, that American practise is not described. It is needless to say that designs which are very successful abroad could not be marketed here owing to the different conditions, particularly with reference to the cost of labor.

The treatment of the interpole motor, while very good, is not as extensive as a good many engineers would desire. There is need of a carefully systematized work of authority on this subject in English, something comparable to Arnold's work in German to which most designing engineers in direct-current as well as alternating-current work are obliged to refer more or less frequently.

The chapters on the Design of Induction Motors are very complete, and by means of the data included would enable one already familiar with the principles to produce very satisfactory designs, but there are certain features lacking and certain methods of treatment which would make it difficult for a person not in the habit of practising design to understand the subject Thus the subject of the leakage reactance or inductance is treated almost altogether as a function of the "circle diagram" and no statement or diagram is given showing the paths of the leakage flux and the effect on the value of this leakage flux of the number and shape of the teeth.

While it is possible to take into account this leakage reactance in the calculation of the characteristics of the machine by means of the circle diagram by referring to data given, it is nevertheless very valuable to thoroughly appreciate during the actual process of design, exactly how much each particular feature of the design contributes to this quantity. This can only be determined by actually deriving the leakage path from the shape of the punchings. Incidentally, the effect of fractional pitch on the leakage reactance is

not very clearly brought out Yet fractional pitch is very generally used in motors of American manufacture.

The chapters on the Design of Small Motors for Manufacture in Large Quantities and on Cost and Weight Coefficients are of undoubted value in concentrating attention on the factors which govern the expense, although the actual values being based on foreign practise would not be of great value to an American engineer

In a book on design as comprehensive as this it seems a pity that some space is not devoted to the mechanical design It is to be regretted that designers of the electrical features of apparatus are so dependent on the mechanical engineer to put their designs and ideas into execution.

Considerable space is given to the single-phase motor both of the induction, series and repulsion types, with the addition of very good introduction stating the logical limitations of the single-phase system

The author and publishers should be congratulated on the excellent work shown in the cuts and curves which contribute considerably to the value of the data included in the book. This is really very extensive and alone would make the book of great value to the designing engineer as a book of reference

WALTER I SLICHTER

Testing of Electromagnetic Machinery By B V. SWENSON and B FRANKENFIELD New York, The Macmillan Co 1911.

This volume is devoted to the testing of alternating-current machinery and is a sequel to the book on "Direct Current Machinery," previously published by the same authors. The book contains a description of a very large number of practical experiments illustrating the phenomena of alternating-current circuits and methods of testing commercial apparatus. It is intended to be used in technical schools in connection with a laboratory course.

The general scheme and methods are based upon the work which has been carried on in the laboratory of the University of Wisconsin under the authors, and contains additions and revisions due to the experience of Professor Bryant at the University of Illinois.

As a result of this collaboration and experience the text covers the field very completely and the methods advocated are those that would be generally conceded as the best and most practical

The book is quite up to date both in its methods and in its scope, thus a treatment of the mercury arc rectifier and the split-pole converter are included, although the treatment of the latter is very brief

It may be suggested that the experiments are resolved into too elementary and simple divisions and that a more efficient use of the student's time would be obtained by combining several of the experiments into one operation. There are 127 experiments listed, very few of which could be omitted from a good course, but these 127 could be logically grouped to cover the same ground in fewer operations.

For the theoretical basis and explanation of each experiment, the student is referred to a very large number of references in each experiment The number of these references will in itself tend to discourage the average student to give any of them proper attention. It would be of more benefit to the student if a simple and concise development of the theory were included in the text with each experiment. However, for instructors in charge of courses these references so systematically arranged will be of great use.

WALTER I. SLICHTER

Economic Geology, with Special Reference to the United States. By HEINRICH RIES, Ph.D. Third edition. New York, The Macmillan Co. 1910. Pp. xxxiv + 589, pls. LVI., figs. 237. $3.50.

The importance of geology in its relations with mineral resources was recognized nearly a century ago in the establishment of official surveys. Still earlier in the European schools of mines the formation and classification of ore deposits were discussed in formal courses of lectures. But the growing development of agriculture, quarrying and mining has brought the science of geology more and more into the

foreground among subjects of importance in general education, and more and more courses in the purely scientific statement of the subject are followed up by those in its applications.

The text-book before us covers the latter field. It aims to carry a student through the various useful minerals and rocks, to instruct him in their modes of occurrence, the principles governing their accumulation and the statistics of their production. The non-metallics are first discussed, beginning with coal. Then follow in order, in Part I., petroleum and related hydrocarbons, structural materials, salines, fertilizers; abrasives, various minor minerals, and finally underground water. The author has freely used maps and pictures and summarizes literature at the close of each chapter. In the matter of clays and their applications he is especially at home from long experience with this particular line of investigation.

Part II. is devoted to the metalliferous deposits. An introductory chapter on the geological principles involved and the scheme of classification to be employed leads up to a systematic description of the ores of iron, copper, lead, zinc, gold, silver and the lesser metals. Again maps are freely used and with geological sections and pictures convey excellent ideas of occurrence and distribution. Statistics add the proper sense of perspective and of relative magnitudes.

The author writes with obvious knowledge and command of his subject. Successive years of presentation to classes and the two previous editions of the work have aided in bringing it to a high grade of excellence. The publishers have cooperated with maps and illustrations, with the result that a concise and very useful manual has resulted.

J. F. KEMP

PSYCHOLOGY IN RUSSIA

AT the eighth annual meeting of experimental psychologists, held at Cornell University, April 17–19, 1911, Professor G. Tschelpanow, of the University of Moscow, described the status of psychology in Russia at the present time. He has been commissioned by his government to study psychological laboratories abroad, in order to perfect plans for the erection and equipment of a psychological laboratory building, the first and most complete of its kind—and to be established at Moscow, in the heart of Russia! This laboratory is the gift of Mr. S. I. Shtchukin, of that city, who has contributed 100,000 Rubel ($50,000) for the building and 20,000 Rubel for its equipment. He is already well known as a benefactor and protector of the modern school of painters, and has a large private museum of modern pictures which is often visited by English and French artists. The new laboratory is also endowed with a library of 3,000 volumes, worth 10,000 Rubel, presented as a memorial by the family of a young instructor of the University of Moscow, who met with an untimely death.

Professor Tschelpanow addressed the audience in German, but he kindly permitted me to translate the notes I had taken and to publish them, in spite of their sketchy, unfinished form, as I considered his remarks of general interest to scientists at large. He said in part:

"Experimental psychology in Russia is still in its beginning, although the first interest for it was aroused as much as twenty years ago. Its progress has been impeded partly by the uncertainty of political conditions, partly by the close affiliation of psychology with philology only, and not with natural sciences, and partly also by the fact that Russian universities have only collegiate rank, so that most of their advanced students still have to go to Germany for their research work.

"Among the older psychological laboratories, that at Odessa has become most widely known through the work of N. Lange. For some time he had but scanty space and only a few pieces of demonstrational apparatus at his disposal. At Kiew the laboratory consists of two rooms which contain demonstrational and other instruments. Moscow is in this respect the most fortunate place of all, because four years ago its laboratory was

started with four rooms and an initial endowment of 3,000 Rubel It now has thirty students in experimental psychology, some of whom are undertaking independent work Among the problems already attacked are the study of reaction-types, Reuther's method of recognition, work on memory-types with the Binet method improved by controlled time-exposure, and the correlation of the three psycho-physical methods in regard to estimation of spatial extent In the teaching of experimental psychology the Russian professors depend very largely upon translations of American text-books, especially those of Sanford and Titchener

"In recent years applied psychology has become very popular and influential, through the work of Netschajeff and his cooperators, who have established about fifty psychological institutes at various *gymnasiums* and secondary schools where psychological instruction has been introduced The method of making mental diagnosis has, however, reached a crucial point in Russia, inasmuch as strong opposition has set in toward a newly developed practise of outlining and analyzing mental abnormalities by reference to characteristic curves, especially when employed by comparatively inexperienced teachers Objective or physiological psychology is represented chiefly by the well-known work of Bechterew and Pawlow, while interest in theoretical psychology still predominates"

After the meeting, Professor Tschelpanow showed and explained the architect's plans for the new laboratory, which is to be a three-story building The basement will contain the heating plant, a workshop, a sound-proof room, space for animal psychology, large electric motors, and the apartments of the janitor and the mechanician On the first floor, an auditorium with a seating capacity of three to four hundred persons and a room for demonstrational apparatus are provided for; furthermore, the director's office, the library, a room for collections of mental products, and a general writing room, are to be located here. The plan of the second floor makes allowance for a small lecture-room, for offices of the assistants, and for about twelve rooms in which the introductory courses for qualitative and quantitative experiments will be conducted The third floor, finally, is to be given up entirely to research, and for this purpose it will be divided into twenty smaller rooms A special feature on this floor is a large switchboard for the distribution of electric power The building will be situated on university grounds, surrounded on all but one side by other university buildings, but removed as far as possible from public traffic From all indications it promises to be an ideal home for the pursuit of psychological investigations, and it is to be hoped that the generous gift of Mr Shtchukin will prove a fruitful example to other countries

L R GEISSLER

CORNELL UNIVERSITY

THE TIME GIVEN BY UNIVERSITY STUDENTS TO STUDY AND RECITATION

IN connection with some committee work in Indiana University the writer was appointed chairman of a sub-committee to ascertain the time given by the students to their work

It is thought that a brief summary of the results might be of general interest. Blank cards were handed to the students of all classes on Monday, February 14, 1910. The students were instructed to fill in the cards for all their courses Each student was to fill out one card only, that is, if the student had an eight o'clock recitation, say, he filled out the card for all his courses If he then went to another class, nine o'clock, say, he returned his card blank.

The cards called for the department, the number of course, the number of hours credit, the number of hours spent per week by the student in recitation or laboratory, and the number of hours spent per week by the student in home or library study. The card had blank spaces so that as many as seven courses could be filled in, if necessary. The total time spent by the students per week on a course was added and then divided by the number of credit hours, thus giving the time spent by the

individual student per week per credit hour for each course

The cards were then arranged in alphabetic order From the mid term reports rolls of all the classes in the university were procured By referring to the cards the time given by the student to the particular course was marked opposite the student s name and the average time per week per credit hour was determined for each course

By summing the totals of the courses and dividing by the total number reporting the average time was determined per instructor and per department as well as the grand average for the university

Due to various causes such as absence of students or forgetfulness of the instructors reports were not obtained from all students Approximately 75 per cent of the students reported About nine hundred cards were returned to the committee A few of these were thrown out because they were not filled out properly The cards showed that for a total of 4 438 registrations 13 951 7 hours per week spent or an average of 3 14 hours per week per credit hours (15 credit hours is regular work at Indiana University) That is the average student spends 3 14 hours on each recitation If the course is one in which no laboratory is required he spends 1 hour in the class and 2 14 hours in preparation If the course is a laboratory course requiring two hour two-and-a-half hour or three-hour periods the student spends 1.14 hour 0 64 hour or 0 14 hour respectively in outside preparation

TABLE I

By Departments

Department	Enrollment	No Reported	Hours per Week per Credit Hour
—	60	50	4.10 hours (highest)
—	304	255	[illegible]
—	5	4	[illegible]74
—	244	18[illegible]	3.58
—	956	65[illegible]	3.55
—	93	78	2.63
—	68	51	2 68
—	107	80	2.52
—	71	50	2.54 (lowest)

In order to give an idea of the range I have arranged three tables—Table I by departments Table II by instructors and Table III by courses giving the enrollment the number of students reporting and the number of hours per week per credit hour starting at the highest and ending with the lowest

TABLE II

By Instructors

Instructor	Enrol ment	No Reported	Hours per Week per Credit Hour
—	38	22	4 25 hours (highest)
	109	95	4 01
	54	50	3 97
—	41	31	2 38
—	69	51	2 17
—	30	19	2 14 (lowest)

TABLE III

By Courses

Course	Enrollment	No Reported	Hours per Week per Credit Hour
—	11	9	5 38 hours (highest)
—	31	25	5 07
—	15	11	4 38
—	4	3	4 30
	10	9	1 92
—	4	3	1 66
—	24	19	1 25 (lowest)

It is true that the figures do not represent the facts in all cases To the lazy student who has knowingly slighted his work the temptation would be great to increase the time of study On the other hand the plodding student would tend to underestimate his time In certain cases the student may have heard that the proper time for the course was about so much Under those conditions the average student will consciously or unconsciously make his figures correspond to the standard However, the averages of large numbers may be taken to be near the true value In any case, the figures are not without interest

R. R. Ramsey

Indiana University,
Bloomington, Ind.,
December 21, 191[illegible]

SPECIAL ARTICLES

BIOLOGICAL CONCLUSIONS DRAWN FROM THE STUDY OF THE TITANOTHERES[1]

THE chief object of this communication is to point out a possible harmony between the "continuity" and "discontinuity" theories of the phenomena of development

The titanotheres, as an extinct family of mammals extending from the summit of the Lower Eocene to the summit of Lower Oligocene times, offer an exceptional opportunity for the solution of the two chief modern questions of evolution first, the mode of transformation of existing characters, second, the mode of origin of new characters The material available is now the most complete of any extinct family of mammals, embracing several nearly continuous series which branch out into a large number of phyla, some of which may be carried through all the phases of transformation The investigation has been carried on with the aid of Dr W K Gregory, and is marked by the introduction of a very exact system of measurements, whereby the various kinds of transformation may be studied in numerical terms This exhaustive research appears to have a significant bearing upon the diverse theories of transformation entertained by the two modern schools of thought, the zoological and botanical, and the paleontological

From the time of Waagen in 1869, who introduced the term "mutation" for the *stages* of the continuous development of certain inconspicuous but genetically important characters in Ammonites, the idea of continuity has become the established law among paleontologists. Neumayr added the conception of "*Mutationsrichtung,*" that is, of trend or direction of development The researches of Hyatt and Beecher were directed rather to the phenomena of recapitulation than specifically to the phenomenon observed by Waagen. Their writings, however, bring volumes of testimony to the law of continuity of development. This law has been established among vertebrates as well as invertebrates The nature of the evidence presented to the paleontologist is entirely different from that presented to the zoologist, as an observer the former is practically immortal, that is, his range of observation, where it is possible to assemble continuous series of organisms, extends over enormous periods of time in contrast to the fleeting and essentially mortal glimpses which the botanist and zoologist may obtain of the fundamental processes of transformation

Over against the idea of continuity, of definite development, and of certain trends of evolution, there have been developed among the students of living animals and plants (Bateson, de Vries and others) the notion of discontinuity and of order or orderly development produced only by selection To this discontinuity de Vries has unfortunately applied the same term "mutation" which was introduced into biological literature by Waagen with entirely different significance, the name *saltation* should be attached to the de Vries hypothesis, until this is done we must speak of "mutations of Waagen" and "mutations of de Vries" The discontinuity conception has been strengthened rather than weakened by the wonderful revelations of Mendelian heredity, including the doctrine of unit characters and of "alternate inheritance"

The only tenet which the "continuous" and "discontinuous" schools of thought hold in common, or rather have reached in common, is that germinal evolution is the chief phenomenon upon which our attention must be concentrated. In the present communication the phenomena resulting from somatic changes or ontogeny, from environment, and from selection may be left out of consideration, and we may direct our thought solely and exclusively upon germinal evolution as it is displayed in the origin of new characters and in the transformation of existing characters in the titanotheres.

In all the sequence of the titanotheres only four kinds of change are observed: (1) *Increase of size.* This happens to be an almost

[1] Abstract of paper presented at the meeting of the National Academy of Sciences, Washington, April 19, 1911. Based upon the author's monograph "The Titanotheres," in preparation for the U. S. Geological Survey.

universal principle in this family, although it is by no means universal among mammals nor even among the Herbivora. (2) *Loss of parts* This plays a very small part in the series of titanotheres as compared, for example, with the horses, since the chief parts lost are one element in the carpus, the trapezium and certain upper and lower incisor teeth (3) *Changes of proportion* This comprehends one of the most important and significant parts of titanothere evolution Such change it is proposed to designate as "allometric," and new parts originating in this way may be termed "allometrons" (4) Continuous definite or *adaptive origins* of new characters, which the writer has previously termed "rectigradations"

Of the above phenomena (1) increase of size and of (2) loss of parts may be left out of consideration, and attention may be directed upon the (3) *allometrons* and the (4) *rectigradations* It is found at once that their mode of appearance or the laws governing them are definite

First, as to *rectigradations*, as exemplified by new cusps upon the teeth or by newly arising horns upon the skull, we find them subject to four important principles (1) Rectigradations appear under the law of ancestral hereditary control, that is, the same rectigradations arise independently at different times in the descendants of remote common ancestors This law has already been enunciated at a previous meeting of the academy and constitutes one of the most important generalizations brought out by the study of the titanotheres. (2) Rectigradations are continuous, arising from infinitesimal and almost invisible beginnings and passing into a stage of usefulness; this principle was pointed out many years ago by the author and described as "definite variation." (3) Rectigradations from the time of their first appearance are subject to the allometric influence of surrounding parts, thus a horn arising as a rectigradation in a brachycephalic skull will assume from the beginning a rounded form; arising in a dolichocephalic skull it will assume an elongate or oval form. (4) It is probable, but has not yet been demonstrated, that rectigradations are subject to fluctuations, that is, are more or less strongly developed around an average mean

Second, the *allometrons* or changes of proportion follow partly the same and partly different laws than those pursued by the rectigradations The most fundamental difference is the following: allometrons arise independently of remote ancestral hereditary control, that is, from a mesaticephalic ancestor there may arise, on the one hand, a dolichocephalic, and, on the other hand, a brachycephalic descendant, when, however, a trend of development, a law which appears to be coincident with the "*Mutationsrichtung*" of Neumayr, is once established then a tendency toward brachycephaly or dolichocephaly, respectively, becomes increasingly manifest, in this sense allometrons resemble rectigradations The second law is that allometrons are continuous This is positively demonstrated in certain phyla, and apparently will be demonstrated in all the phyla as soon as a full series or sequence is obtained Any other theory of change of proportion but continuity is untenable in the face of the hundreds of measurements which especially demonstrate progressive brachycephaly Measurements demonstrating progressive dolichocephaly and cytocephaly, or the bending down of the facial upon the cranial region of the skull, are based on less complete series

It has been found convenient to introduce a series of cephalic indices of the ratios between breadth and length similar to the cranial indices used in anthropology Thus, breadth — length gives the cranial index of a titanothere, and the gradual transformation from mesaticephaly into brachycephaly or dolichocephaly may be expressed in exact numerical terms Every bone of the skull enters into these remarkable transformations, and every single bone has its own individual percentage of increment. The evolution of every part is differential. Thus there is no general stretching of the skull in dolichocephaly, as if it were composed of india rubber; the elongation may be confined to cer-

tain regions It has recently been found that the ancestral titanotheres are dolichocephalic, of the type known as proopic-dolichocephaly because the chief elongation is in front of the orbital region Their descendants are also dolichocephalic, but the type is opisthopic dolichocephaly, that is, the chief elongation is behind the orbital region

Similar allometric indices are also found in the limbs For example, the ratio of the length of the tibia to that of the femur is very significant and is constantly changing in adaptation to weight and to speed.

Considering the transformation of the titanotheres in comparison with that of the horses and many other lines of mammals, where successive series have been obtained, we observe again exactly similar phenomena It *appears that the law of continuity, of orderly and in a sense of predetermined transformation can now be established beyond refutation*

The question then arises whether these laws of "continuity" can be harmonized with the potent demonstration that certain new characters and certain new proportions arise as saltations or discontinuously The hypothesis which is here advanced is that continuity is the normal mode of development under natural conditions, that there are certain definite trends or tendencies, that there is in continuous series a "*Mutationsrichtung*," that by this continuous development the greater number of so-called "unit characters" have arisen, that occasionally, however, new unit characters may and do arise suddenly The hypothesis may be expressed as follows that the normal development of unit characters is a continuous progress, that under certain abnormal conditions, as of sudden change of environment, certain new unit characters may appear suddenly, that the cross-breeding of pure natural races in which unit characters have been built up by continuous processes breaks up these unit characters into a mosaic and gives rise to the larger part of the apparently saltatory or discontinuous phenomena which are being observed by the modern experimentalists.

As illustrations of this hypothesis, take as a very simple one the transformation of the head form in various human races, the development of dolichocephaly and of brachycephaly has in all probability been by continuous transformation in one direction or the other In support of continuity is the evidence adduced among the titanotheres. When dolichocephalic and brachycephalic races intermingle, the fact that dolichocephaly or brachycephaly is a unit character appears at once in the non-blending of head form subject to the law of alternate inheritance Another illustration is afforded by the results of the interbreeding of pure stocks of the horse, namely, according to the observations of Ewart, the Arab, or plateau type, the Przewalsky, or steppe type, and the draught, or forest type Each of these pure original stocks apparently acquired by gradual transformation a very large number of distinctive characters displayed in the head, in the teeth, in the backbone, in the limbs, and last but not least in the psychic activities of these three great strains which have been bred for ages among very diverse environmental conditions As soon as these three pure stocks are intermingled the fact that each is a mosaic of an enormous number of single, or unit characters becomes apparent in the mosaic type of horse which is produced, a horse showing singly or in groups various unit characters of the plateau, steppe or forest types The transformation which, for example, has built up respectively the slender cannon bones of the desert and heavy cannon bones of the forest type has been, we have every reason to believe, a continuous, or progressive, or allometric change On interbreeding, these slender or massive proportions may partly blend or may be detached as "units" from the progressively slender or massive head types to which they belong.

By far the greater number of the experiments carried on in support of the theory of discontinuity have been among hybrids, crossed strains, artificial strains, or strains subjected to unnatural changes of environment. It is important, therefore, for experimentalists to extend their work among abso-

lutely pure, natural races Wherever nature is experimenting, as discerned by the field zoologist in the observation of geographic series from east to west, and north to south, from humid into arid regions, we are repeatedly finding geographically continuous series which shade into each other in color, in skull proportion, and limb proportion, and all other characters by continuous degrees of change

HENRY FAIRFIELD OSBORN

UNDERGROUND TEMPERATURES

IT is an established fact that as the earth is penetrated below the limit of seasonal changes the temperature is invariably found to rise Observations made in deep borings, wells, tunnels and mines have been sufficiently numerous over the earth's surface to indicate that the rise of temperature with depth "can not be explained on mere local causes" The rate of temperature increase is not uniform but is found to be quite variable, not only in different localities, but frequently in the same boring This variation of heat increment is doubtless due to a number of causes,[1] such as differences in the thermal conductivity of rocks which vary in lithologic character, structure and contained water, inequalities of topography, circulation of water, chemical action, compression, etc. Whether the heat increment observed in the superficial zone continues to the center of the earth is not known, as observations are limited to only a little more than 1/4,000 of the earth's radius. Some investigators regard it as more probable that the rise of temperature diminishes below the superficial zone.

The conducting power of rocks was first accurately measured by Forbes[2] and later by others. Forbes found that trap rock was the poorest conductor and solid sandstone the best. Sir Archibald Geikie[3] says, "the lighter and more porous rocks offer the greatest resistance to the passage of heat, while the more dense and crystalline offer the least resistance." The British Association Committee on Thermal Conductivities of Rocks[4] expressed the resistance of quartz by the number 114, basalt by 273, and cannel coal by 1,538 The same authority[5] records that heat travels four times as fast in foliated rocks, such as slate and schist, in the direction of cleavage than across it. It has been shown also that thermal resistance is lowered by the presence of interstitial water

The subject of underground temperature attracted attention as early as nearly two centuries ago, when observations were made in the mines of Alsace by Gensanne in 1740, who found an increase of 1° F in 50 feet Among some of the earlier observers may be mentioned Saussure, Humboldt, Daubuisson, de Tebra, Forbes and Fox, Henwood, Cordier, De la Rive and Marcet, Phillips and others

From 1868 onwards the British Association Reports contain valuable contributions by the committee on underground temperatures, and a summary is published in the volume for the year 1882. In 1886 Professor Prestwich's[6] valuable contribution on the subject of underground temperatures appeared, in which he collated all available data up to that time This paper was later revised and published in his "Collected Papers on some Controverted Questions of Geology," 1895, pp 166–279 Observations have been made and data bearing on this subject have been contributed at intervals to the literature from 1886 to the present time, with the conclusion that while there is an undoubted increase in temperature downward, the rate is more variable than was at first supposed

Professor Prestwich gave the number of different localities and mines where observations were recorded as 248, and the number of stations 530. He found, with but few excep-

[1] Chamberlin and Salisbury, "Geology," Vol. I., 1904, pp. 544–547; Geikie, A., "Text-book of Geology," Vol. I., 4th ed., 1903, pp. 63–64.

[2] *Trans. Roy. Soc. of Edinburgh*, Vol. XVI., p. 211.

[3] "Text-book of Geology," 4th ed., 1903, Vol. I., p. 63.

[4] Rept. Brit. Asso. Adv. of Science, 1875, p 59

[5] [illegible]

[6] *Proc. Roy. Soc. of London*, 1886, Vol. XLI, pp. 1–[illegible]

tions, that the earlier observations were inferior and of little value for purposes of accuracy, due chiefly, he says, to the imperfection of instruments and methods of experimentation. Because of the careful digest by Professor Prestwich of the voluminous data bearing on this subject, I regard it of sufficient interest to note briefly the following extracts from this valuable paper The author classified the recorded results on underground temperatures into—(1) metallic mines, (2) coal mines, (3) wells and wet borings and (4) tunnels. The increase of temperature was found to be: (1) metallic mines, from 1° F. in 47 feet to 1° F in 126 feet, (2) coal mines, from 1° F. in 45 feet to 1° F in 79 feet, (3) wells and borings, from 1° F. in 41 feet to 1° F in 130 feet; (4) tunnels—Mont Cenis, 1° F for 79 feet; St. Gothard, 1° F for 84 feet. The mean of these results gave 1° F in 64 feet Subsequent corrected readings in the two tunnels reduced the mean to 1° F in 60 feet

Professor Prestwich regarded the differences in results obtained in mines, wells, etc, indicated by an examination of the tables, to be attributed to the fact that the geological conditions were unlike, and the disturbing causes of a different order The main disturbing causes in the different groups of openings made are stated and discussed In coal mines they are stated as (1) loss of heat through exposed surfaces, (2) effects of ventilation, (3) other causes, such as crushing of rock, escape of gas, and effects of irregularities of surface (pp. 9–21). There are local variations according to structure, percolation of water, etc. From the reliable cases, the mean increase for coal mines was found to be 1° F in 50 feet.

In metalliferous mines the main causes affecting thermal conditions are given as (1) ventilation, (2) percolation of water, (3) hot springs, due (a) to chemical decomposition and (b) to water coming from great depths[7] (pp 25–34). The mean thermometric gradient was found to be 1° F. in 44 feet in rock, and 1° F in 42.4 feet in springs, with an average for the two of 1° F. in 43.2 feet.

In wells and borings the main disturbing causes are regarded as (1) pressure on the instruments, and (2) convection currents. The mean thermometric gradient in this group of openings was found to be for non-flowing wells 1° F in 51.2[8] feet, in flowing wells 1° F in 49.1[8] feet, with an average for the two of 1° F in 50[8] feet

A paper entitled "Rock Temperatures on the Rand and Elsewhere," by E M. Weston,[9] published in a recent number of the *South African Mining Journal* is of interest The tables which follow below are taken from this paper

Rock Temperatures in Depth on Witwatersrand Mines

Rock Temperature at	
1,000 feet	68 75° F
2,000 feet	73 53
3,000 feet	78 35
4,000 feet	83 15
5,000 feet	87 95
6,000 feet	92 75
7,000 feet	97 55
8,000 feet	102 35

General rate of increase, 1° F for 250 feet.

In the Lake Superior copper district, the Tamarack shaft is reported to have reached a depth of 6,070 feet, and the Red Jacket shaft a depth of 5,315 feet. The rate of increase in temperature is given as 1° F. for 209 feet. In a note published by Professor Alexander Agassiz in 1895, the greatest depth reached in the Calumet shaft was 4,712 feet, which showed an average increase in temperature of 1° F. for 223.7 feet.[10] Two bore holes are reported put down in Silesia to depths of 6,500

[7] In his revised paper, Professor Prestwich adds "the working operations" to the list of causes affecting thermal conditions in metalliferous mines. "Collected Papers on some Controverted Questions of Geology," 1895, p. 179.

[8] 52.2, 50 6 and 51.4 feet, respectively, in the revised paper. *Ibid.*, 1895, pp. 226 and 231.

[9] *South African Mining Journal*, November 12, 1910, p 417.

[10] "On Underground Temperatures at Great Depths," *Am. Jour. Sci.*, 1895, Vol. L., pp. 503–504.

feet and 7,847 feet, with bottom temperatures of 158° F. and 181° F., respectively.

Rock Temperatures in Brazil Mines

(St. John Del Rey Mine, Minas Geraes)

Rock Temperature at	
324 feet	70.0° F.
624 feet	71.0
924 feet	74.0
2,073 feet	78.0
2,824 feet	84.5[11]
3,724 feet	88.0
4,024 feet	95.0

Vertical depths of more than 4,500 feet are reported reached at Bendigo, Victoria, Australia, with a rock temperature of 110° F. at 4,000 feet. At the Adalbert mine in Bohemia the greatest depth is stated to be 3,600 feet, with a rock temperature between 3,500 and 3,600 feet of 113° F.

Rock Temperatures in Kalgoorlie Mines

Rock Temperature at	
1,400 feet	84° F.
1,700 feet	83
2,000 feet	83
2,300 feet	84

Data bearing on artesian-well temperatures in the Dakotas were tabulated and discussed by Darton[12] in 1898, which indicated very high and variable temperatures and for which no satisfactory explanation was offered. Records from 49 localities were given in which the depth of well varied from 432 feet to 2,500 feet, and the rate of temperature increase ranged from 1° F. in 17.5 feet to 1° F. in 45 feet, with an average of 1° F. in 35.4 feet. At the Pittsburgh meeting of the Geological Society of America, December, 1910, Mr. Darton read a paper entitled "A List of Underground Temperatures in the United States" in which he said: "The rate of temperature increase has been found to be very variable, but in places there is a marked relation to geologic features."[13]

The records of the Committee on Underground Temperatures, of the British Association for the Advancement of Science, show a range of 1° F. in less than 20 feet to 1° F. in 130 feet, with an average of 1° F. in 64 feet. Professor Prestwich concluded that the average increase in temperature was 1° F. in 47.5 feet (p. 55). Lord Kelvin assumed the rate of increase to be 1° F. in 51 feet. A lower rate of increase is indicated in more recent deep borings that have been carefully measured. From the data given above, quoted from the article by Weston on increase of temperature with depth in metalliferous mines, the general rate of increase in thermometric gradient for the different localities is in the Witwatersrand mines from 1,000 feet to 8,000 feet, 1° F. for each 250 feet in depth, in the copper mines of the Lake Superior district, 1° F. for each 209 feet, in the St. John Del Rey mine, Brazil, 1° F. for each 156 feet, approximately, and in the Kalgoorlie mines, Australia, practically no variation in temperature is indicated between the depths of 1,400 feet and 2,300 feet.

Professors Chamberlin and Salisbury give the following list of records:[14]

Locality	Depth in feet	Rise of 1° F
Sperenberg bore (Germany)	3,492	in 51.5 feet
Schladeback bore (Germany)	5,630	67.1
Cremorne bore (N. S. Wales)	2,929	80
Paruschowitz bore (Upper Silesia)	6,408	62.2
Wheeling well (W. Va.)	4,462	74.1
St. Gothard tunnel (Italy Switzerland)	5,578	82
Mt. Cenis tunnel (France Italy)	5,280	79
Tamarack mine (N. Mich.)	4,450	100
Calumet and Hecla mine (N. Mich.)	4,939	103
Ditto, between 3,324 feet and	4,837	93.4

In commenting on these records the authors say:

[11] Equals sea level.

[12] Darton, N. H., "Geothermal Data from Deep Artesian Wells in the Dakotas," *Am. Jour. Sci.*, 1898, Vol. V. (N. S.), pp. 161–168.

[13] "Preliminary List of Papers, 23d Winter Meeting, Geol. Soc. America, Pittsburgh, Pa.," December, 1910, p. 2.

[14] "Geology," Vol. I., Geologic Processes and their Results, 1904, p. 543.

It is to be noted that even these selected records vary a hundred per cent Very notable variations are found in the same mine or well, and often much difference is found in adjacent records, especially those of artesian wells Some of these are explainable, but the full meaning of other variations is yet to be found[19]

In conclusion, it may be stated that from recent figures bearing on this subject, no general law is observed in the increase of rock temperature with depth, and in general the increment of heat is lower and more variable than indicated by the earlier observers

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[19] *Op. cit.*, pp. 543–544.

THE SCALES OF THE DIPNOAN FISHES

I AM greatly indebted to Dr G. A Boulenger for scales of the few living members of the very interesting and remarkable subclass known as Dipnoi or Dipneusti. The result of their examination is quite surprising to me, and has, I think, an important bearing on their relationship with other fishes

Neoceratodus forsteri, from Queensland, has very large oblong scales, one before me being 55 mm long and 34 mm broad, 20 mm or less of the length being exposed in the living fish In general appearance, the scales are not unlike those of *Heterotis*, except for size The broad nuclear field, far apicad of the middle, is rugose, the circuli (fibrillæ) are all very fine, and both basal and apical are longitudinal; the basal fibrillæ are moniliform (minutely tuberculate), and in the lateral fields the whole surface is minutely rather irregularly tuberculate. Thus in its longitudinal fibrillæ *Neoceratodus* agrees with *Amia* and *Albula;* in having the fibrillæ tuberculate or beaded it agrees with *Albula* and the Osteoglossidæ. At first sight it seems that there are no radii in *Neoceratodus*, but closer inspection shows a complete system of fine radial reticulations, especially well developed in the lateral areas, where it accords perfectly with the network-pattern of the Osteoglossida! This exceedingly characteristic feature is now known, therefore, in the Dipnoans, the Osteoglossids and the Mormyrids[1]

Having determined these facts, I turned with eagerness to the material of *Lepidosiren* and *Protopterus* In these fishes the scales are completely enclosed in the skin, but are, nevertheless, quite large (fully 8 mm. diameter in *Protopterus*), and shaped much as in *Osteoglossum* Both have a strong radial network, while the circuli are reduced to innumerable fine tubercles or coarse granulations, approaching the condition of the lateral areas in *Neoceratodus* *Protopterus annectens* from Africa (Gambia) and *Lepidosiren paradoxa* from Brazil have scales of entirely the same type, but in the *Protopterus* the network is more regular and more obviously similar to that of the Osteoglossids In both the fibrillar granulations tend to run in lines near the margin, but this is rather more marked in *Lepidosiren,* the indications are in each case of longitudinal (not circular) fibrillæ The general results may be thrown in the form of a table, thus:

(*A*) Basal fibrillæ longitudinal
- (*a*) Fibrillæ moniliform or tuberculate.
  - (1) With radial network . . . Dipneusti.
  - (2) Without radial network . . . *Albula* and *Dixonina*.
- (*b*) Fibrillæ not tuberculate, no radial network . . . *Amia calva, A scutata*.

(*B*) Basal fibrillæ circular (normal circuli); radial network present
- (*a*) Fibrillæ tuberculate . . . Osteoglossidæ.
- (*b*) Fibrillæ not tuberculate . . . Mormyridæ.

It is also to be remarked that *Gymnarchus* (Mormyridæ), *Heterotis* (Osteoglossidæ), *Lepidosiren* and *Protopterus* all have larvæ with external gills.

Dr Boulenger has very kindly sent me the scales of the Osteoglossids *Scleropages formosus* from Borneo, *Scleropages leichardti* from Queensland and *Osteoglossum bicirrosum* from Cadajos, Brazil. They are practically circular (*S. leichardti* rather broader), and all have exactly the same structure, notwithstanding the wide geographical separation The scales of *Heterotis niloticus* differ

[1] For the last, see Smiths. Misc. Coll., Vol. 56, No 3, p 2.

in being oval *Pantodon* (fam Pantodontidæ) also has strongly tuberculate basal circuli T. D. A. Cockerell

University of Colorado

SOCIETIES AND ACADEMIES

THE NEW YORK ACADEMY OF SCIENCES
SECTION OF BIOLOGY

The regular monthly meeting of the Section of Biology held at the American Museum of Natural History, March 13, 1911, was devoted to a public lecture by Dr George A. Soper, president of the Metropolitan Sewerage Commission, on the "Scientific Aspects of the Work of the Metropolitan Sewerage Commission"

In connection with the investigations of the commission upon the pollution of the waters of New York harbor from various sources, a great amount of scientific work has been done by Dr Soper and his assistants The most interesting features of this work and its results were dwelt upon in popular manner by the lecturer

At the regular monthly meeting of the section held at the American Museum of Natural History, April 10, 1911, Chairman Frederic A Lucas presiding, the following papers were read

A New and Peculiar Porpoise from Japan Roy C Andrews

The speaker exhibited photographs and parts of the skeleton of a new porpoise secured in the summer of 1910, in Rikuzen province, Japan This specimen is allied to *Phocæna dalli* True, and with that species forms a distinct group of *Phocæna*-like porpoises which deserves generic rank This group resembles *Phocæna* externally, but has white side and ventral areas sharply defined from the black of the upper parts, a falcate dorsal fin, and vertebræ numbering 95 or more The type of the new genus to which *Phocæna dalli* was referred is the specimen which was secured in Japan, and has been formally described in a *Bulletin* of the American Museum of Natural History, now in press

The Japanese porpoise presents characters, both externally and in the skeleton, which distinguish it from all other members of the entire family. The caudal peduncle shows a strongly marked "hump," and ventrally a prominent concavity which gives the posterior portion of the body a most extraordinary appearance The neural spines of the entire vertebral series are extremely long and slender, reaching a height much greater than in any other known member of the Delphinidæ The transverse processes are also very long and rod like The number of vertebræ is 95, approaching closely *P. dalli*, which has 97 The scapula is unlike that of any other member of the family in that its height almost equals its greatest breadth, and it is in general shape somewhat like that of a Baleen whale

The specimen is, on the whole, one of the most remarkable members of the Delphinidæ that have thus far been discovered

Observations on Birds and Fishes made on an Expedition to Florida Waters J T Nichols

This paper concerned itself with a trip through Florida waters on Mr Alessandro Fabbri's yacht *Tekla* in the interests of the American Museum's department of fishes

Attention was called to the abundance of the white ibis and Louisiana heron, contrasted with the scarcity of aigrette bearing herons After a brief mention of the work and the results obtained, the balance of fish life in a fresh water outlet of the everglades was compared with the balance of fish life in the salt water as at Key West

In the former situations gar pikes (*Lepisosteus*) were abundant, as were various Centrarchids (among them the large mouthed bass and blue gill sunfish) which darted in and out through the little channels among the weed, but which did not drive head first through the masses of weed as did the leathery skinned gars, and only made quick sallies into the shallower and less open waters, where various species of Pœciliids, especially *Gambusia*, and *Fundulus goodei* were tremendously abundant The surprising freedom from mosquitoes was mentioned and it was pointed out how the existing balance of fish life was favorable to a great abundance of *Gambusia*, etc, which might be expected to prey on mosquito larvæ The Centrarchids would be likely to hold in check a fish like the banded pickerel, which would have followed these small fishes into the shallows where the Centrarchids did not follow them, and perhaps materially reduced their numbers The situation here where the large primitive gar, the spiny rayed modern Centrarchids and the abundant intermediate Pœciliids made up the bulk of the fish population, was compared with the more complicated marine situation where large selachians and spiny rayed basses, snappers, grunts, wrasses, scorpion fishes, etc., and schooling herrings and anchovies of various sorts in a way constituted homologous classes.

L. Hussakof,
Secretary

SCIENCE

FRIDAY, JUNE 2, 1911

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PROFITABLE AND FRUITLESS LINES OF ENDEAVOR IN PUBLIC HEALTH WORK[1]

IT is in accord with the spirit of this Congress to consider public health questions either from the point of view of things already accomplished by the application of the scientific method or from that of things to be done I have chosen to speak especially of "the saving of waste and increase of efficiency" still to be expected when public health problems are approached in a scientific spirit

It is well recognized to-day by many experts that while some of the ordinary activities of municipal health departments are of unquestionable value in conserving the health of a community, others are relatively ineffective or possibly worthless. One well-known writer[2] has thus expressed himself on this point

> I boldly assert that if every case of communicable disease were promptly reported to the proper local board of health and as promptly placed under effective sanitary control and so kept until danger of infection had passed, all the other present day activities of boards of health, whether local, state or national, with the exception of those directed against certain causes of infant mortality, and the possible further exception of some food and drug inspection, might be dropped with no appreciable effect upon the general health or mortality of any of our states or most of our cities

In all fairness it must be admitted that a part of the energy of almost every municipal health department in this country

[1] Paper presented before the Congress of Technology, Boston, April 10, 1911, to commemorate the fiftieth anniversary of the granting of the charter to the Massachusetts Institute of Technology.

[2] M N. Baker, chairman Committee on Municipal Health and Sanitation, National Municipal League.

is devoted to combating imaginary dangers or applied to tasks that have only a remote bearing on the public health.

This condition, as a rule, is not due to ignorance on the part of health officials, but to the pressure of public opinion. Such pressure is often exerted directly through legal ordinances passed by uninformed legislative bodies, but sometimes also through agitation by mistaken enthusiasts or through other channels of public opinion. Back of the whole situation is the existence in the public mind of wrong or antiquated conceptions of disease and the causes of disease. It was unfortunate in many respects for the cause of public health that much of the popular interest in health matters was evoked before the germ theory of disease and its corollaries became fully developed. As the result of premature generalization the public has warmly espoused a number of wrong conceptions of disease and of ways of preventing disease. To be specific, two instances of this confusion are found in the demand for garbage disposal and plumbing inspection.

Sanitarians do not admit that even a grossly improper method of garbage disposal can have much to do with the spread of disease in a sewered city or that diphtheria or typhoid fever or any other disease is properly attributable to the entrance of sewer air into dwelling houses. So firmly embedded in public belief, however, is the connection of piles of decaying garbage with outbreaks of infectious disease, and of "defective plumbing" with all sorts of maladies that to the average citizen "garbage disposal" and "plumbing inspection" bulk large as the chief if not the only activities of a municipal health department.

In the light of our present knowledge we may well ask what are the actual dangers to health from these two sources? It is now well known to bacteriologists that disease germs do not "breed" in garbage heaps, but that on the contrary if added from outside they speedily die off. The offensive odors of decomposition may be unpleasant and undesirable, there is no evidence that they produce disease or dispose to disease. On the other hand, it may be argued that the existence of heaps of decomposing organic matter tends to maintain or create general habits of uncleanliness which themselves are detrimental in a roundabout way to the health of a community. And again it is known that the house-fly may breed in garbage piles, particularly if horse manure is present, and that under certain conditions this noxious insect may become the bearer of disease germs to food. But when the worst is said it must be admitted that the known danger to health from garbage piles and "dumps" is relatively insignificant compared with the danger from other well-known but less popularly feared sources. Disease does not originate in garbage piles, however offensive they may be, the house-fly, however disgusting and annoying its habits, suffers from no disease transmissible to man, and does not convey disease unless it has access to material in which disease germs are present. The truth is that garbage disposal in large cities is more a matter of municipal housekeeping than of public health, proper methods of garbage collection and destruction must be urged rather from economic and esthetic considerations than on hygienic grounds. There are of course certain features in the handling of refuse and waste that need hygienic control, just as there are in street cleaning, but the problem is essentially not one of public health. At present in some cities the department of health is burdened with the task of caring for the city waste and its success or failure as a conservator of the

public health is too often measured by the frequency with which coal ashes are scattered in alleys or the length of time that decaying vegetable matter remains in tin cans in hot weather. In some cases the larger part of the annual health department appropriation must be expended for garbage collection and disposal, leaving only a pitifully small residue for other needs. To mention a single instance, the collection and conservation of garbage and ashes cost the Minneapolis Health Department in 1909 about $57,000, leaving approximately $43,000 for all the other activities of a health department serving a city of over 300,000 inhabitants.

One thing should be clearly understood by municipal authorities and by the general public, that regular collection and cleanly handling of ashes and table scraps is not one of the surest and most profitable ways of protecting health and preventing disease. Efficient administration of this branch of public work should not be allowed to take the place of measures that directly affect the public health.[8]

Few dangers to health have loomed larger in the public eye than that from "sewer gas." Elaborate and amazingly expensive systems of plumbing are required by law to be installed in every newly erected dwelling house in our large American cities. Plumbing inspection today occupies a large part of the working force of many municipal health departments. In Baltimore in 1908, to cite a single instance, this work was carried out by one inspector of plumbing, seven assistant inspectors of plumbing and one drain inspector at a total salary cost of $8,250 or about one tenth of the total salary appropriation for all public health work. And yet, if all the most recent and searching investigations such as those of Winslow and others are to be believed, the actual peril to health involved in the entrance of small quantities of sewer air into houses is so small as to be practically negligible. It may be questioned whether plumbing inspection, as ordinarily conducted, can be shown to save a single life or prevent a single case of disease. There is certainly no reason to suppose that any infectious disease is due to germs carried in sewer air. It might reasonably be maintained that slightly leaky gas fixtures are a much more serious menace to the health of house dwellers than defective plumbing. At all events our present knowledge affords small justification for the expenditure of public money to insure that the odor of peppermint does not enter our houses when oil of peppermint is designedly introduced into the house drains. It may be worth while for the house builder to satisfy himself of the character of the plumbing as of the character of the mortar, but compulsory inspection by public officials is hardly warranted on the ground of a high degree of demonstrated danger to the public health. It is certain, too, that the enforced installation of immensely complicated and elaborate piping and trapping systems simply adds to the cost of building without any compensating hygienic advantages. The plumbing ordinances of our large cities often contain inconsistencies and contradictions, what is required in one city being sometimes forbidden in another. A revision and simplification of municipal plumbing regulations, a minimizing of official inspection and especially an educa-

[8] Any one who fancies that to depreciate garbage disposal as a health measure is flogging a dead horse will be disabused of this impression if he has experience with the beginnings of a typhoid epidemic and learns how often public attention is diverted from significant issues like water-supply, milk-supply, and contact, by appeals to the prejudice against slovenly ways of handling harmless household refuse.

tion of the public to the fact that diphtheria, typhoid fever and scarlet fever have never been definitely traced to sewer air or bad plumbing are reform measures that might release a considerable sum of public money for use in really profitable lines of sanitary endeavor

In the matter of heating and ventilation enormous sums have been spent and are being spent to "renew" the air in rooms and public assembly halls and to introduce "pure air" in what has been assumed to be necessary amounts And yet if the work of Beu,[4] Heymann, Paul, Erclentz, Flugge,[5] Leonard Hill and others means anything it demonstrates that the whole effect from "bad air" and crowded rooms is due to heat and moisture and not to carbon dioxid or to any poisonous excretions in expired air When all the effects of "crowd poison" upon a group of individuals in an experimentally sealed chamber can be eliminated by rapidly whirling electric fans it is useless any longer to look upon carbon dioxid as "a measure of danger" If we recognize that all the discomfort from breathing air in a confined space is due to a disturbance of the thermal relations of the body, the problem of ventilation becomes very different from what has usually been supposed In temperate climates at all events it ought to be much simpler to provide for proper heat regulation of the body than to warm a large volume of outside air and introduce it into a building continuously or at stated intervals It may well be asked whether the elaborate legal regulations governing the "supply" of air and the cubic feet of bedroom space have a real basis in scientific knowledge If over-heating, moisture-content and stagnation of the air are the chief things to be avoided, may this end not be reached more effectively and less expensively than by present methods?

One conspicuous function at present required of or voluntarily exercised by health departments is the practise of terminal disinfection after cases of infectious disease This has come to play a large part in municipal health activities and is responsible for an important share of the expense In Boston, for example, in 1909, about one tenth of the annual appropriation was expended for disinfection One of the most experienced New England city health officers has recently seriously questioned the value of such an expenditure[6] After a study of the ratios of recurrences in certain diseases he concludes that, "Both theory and facts, so far as any data are available, indicate that terminal disinfection after diphtheria and scarlet fever is of no appreciable value" This view has met with strong support from the experience of a number of English health officials, even if it can not be regarded as conclusively proved Every one now knows that the large sums of money spent in measures of disinfection directed against yellow fever gave little return in added safety We can hardly take for granted that any process of combating disease is effectual simply because it is customary or traditional It is evident that the whole question of disinfection needs to be studied afresh with a view to actual efficacy. It is not a subject for laboratory experimentation alone, but must be investigated as a problem of practical public health administration

Other instances of the application of energy and money to measures apparently of slight or doubtful value might be cited, but those already given are fairly typical The question that should be asked in every

[4] *Zeitschr f Hyg*, 1893, 14, p 64
[5] *Zeitschr f. Hyg*, 1905, 49, p 363
[6] Chapin, *Jour Amer. Public Health Assoc*, 1911, 1, p 32.

case is not whether a particular measure is entirely devoid of value, but whether it is the most effective way of utilizing available resources As matters now stand there are a number of unquestionably valuable measures that can not be prosecuted with sufficient vigor because of the enforced diversion of funds into other and less profitable channels

Efficacious measures may sometimes be distinguished from the fruitless or relatively unprofitable by their direct and unmistakable outcome in the saving of life and the prevention of disease. A few illustrations may be noted

The importance of control and supervision of the sources of public water supply has long been recognized, but the importance of controlling the quality of the public milk supply, although frequently urged by sanitarians, is not always appreciated At the present time in the great majority of American cities it is safe to say that for every case of infectious disease due to drinking water ten cases are caused by infected milk It is difficult to secure adequate funds for the sanitary control of the milk supply By sanitary control of milk is meant not the upholding of a rigorous standard of butter fat and total solids, but the maintenance of proper standards of cleanliness and health for dairy cows and especially the safeguarding the milk from infection during collection and transportation. Under some conditions the protection of the consumer against milk-borne infection may be best brought about by compulsory pasteurization of that portion of the milk supply which can not otherwise be raised to proper standard Whatever method of control be adopted, it is certain that any genuine improvement in the character of a milk supply will be followed in the long run by a lessening in the amount of typhoid fever, diphtheria, scarlet fever and to some extent tuberculosis The early detection of a single case of typhoid fever or scarlet fever on a dairy farm may be the means not only of preventing an extensive epidemic, but of avoiding the formation of scores of new foci which can in turn serve to light up subsequent cases for many years Proper pasteurization of milk has been followed in many cities, as in Glasgow, Liverpool and London, by an immediate and material reduction in the amount of typhoid fever In other words, the connection between an expenditure of public money and a direct return in prevention of disease can be more clearly demonstrated in the case of milk-supply control than in some other of the usual municipal health department activities

The question whether the quality of a city milk supply can be more favorably influenced by inspection and supervision at the source, or by generally enforced and controlled pasteurization is one upon which there is still some difference of opinion among experts. There is little doubt, however, that simply as a matter of economy of administration much is to be said at present in favor of centralized pasteurization of a large portion of the supply Viewed as a method for preventing a large number of cases of infectious disease at relatively small expenditure the pasteurization of milk certainly ranks high among effective health measures

One of the important bacteriological advances of the last few years has been the discovery that a considerable number of healthy persons, convalescents or others, harbor disease germs and that these persons are important agents in spreading disease. The detection and proper treatment of disease-germ carriers, particularly in the more serious diseases and before or in the early stages of an epidemic, is now recognized as an important although difficult

task. The whole question of the control of germ-carriers is one that needs more careful study with a view to determining the actual results of the methods adopted. From this point of view, inspection of school children, especially at the beginning of the school year, is probably to be classed as a highly profitable activity, although it is to be wished that fuller and better-studied statistics were available.

Inspection of school children is highly valuable, also, in detecting various common congenital or acquired defects. If the defects are remediable, their early discovery may avoid development into permanently crippling disorders. In other cases, the application of simple corrective or palliative measures may greatly increase the industrial efficiency of the individual. If the defects are not remediable, their detection will at all events prevent the choice of unsuitable occupations, and will indicate desirable lines of education.

In rural communities, undoubtedly one of the simplest, as well as most important, health protective measures is the adoption, under compulsion if need be, of a safeguarded and standardized form of barrel privy.[7] A corollary hardly necessary to mention is the total abolition of the privy in all thickly settled towns. For lack of such regulations soil pollution occurs, the house-fly finds an opportunity to transfer disease germs from excreta to food, and typhoid fever and hookworm disease become constant plagues over wide regions.

In the campaign against tuberculosis it is perhaps too early to evaluate the numerous methods that have been proposed for lessening or eradicating this disease, but it is already evident that some are more directly repaying than others in proportion to the effort involved. Among the methods for which public funds are legitimately available none is more promising than the provision of sanatoria for advanced cases of consumption. Newsholme and Koch have shown that the general diminution in the death rate from tuberculosis observed in most countries can be more reasonably attributed to the establishment of sanatoria than to any other factor, and that in addition to its humanitarian advantages, the segregation and proper control of the advanced and dangerously infective cases is one of the most useful methods that can be employed by the community to protect itself against the spread of tuberculous infection.

Another field in which practical workers are convinced that certain measures have direct efficacy in saving life is that of infant mortality. It has even been said that for the expenditure of a certain sum the saving of a life can be guaranteed. Certain it is, that in few public health activities is the ratio between effort expended and results obtained so clearly seen. No one doubts to-day that prompt notification of births, education of the mother through any one of a number of agencies, and special provision for suitable feeding of infants during hot weather are factors that are bound to tell powerfully in the reduction of infant mortality. It may confidently be asserted that the degree of success achieved in this field will be limited only by the amount of endeavor the community is willing to put forth.

It is impossible at present to apply direct tests of efficiency to some measures that undoubtedly promote health. The influence of playgrounds, public baths, regulation of the hours of labor in extra-arduous industries and the like is real if it can not be accurately determined or estimated.

[7] See Public Health Reports for 1910, published by the Public Health and Marine Hospital Service, articles by Stiles and Gardner, and Lumsden, Roberts and Stiles.

Certain activities of a health department may be worth continuing for their educational value, although their direct utility may be questioned. Many topics need investigation in order to discover their real bearing upon the public health. Among these are such matters as the effect of a smoky atmosphere, the alleged nervous strain due to city noise and numerous important questions in the domain of food adulteration and contamination. Premature and drastic action by health authorities in matters concerning which there is profound disagreement among experts may cast discredit on other lines of activity in which there is and can be no difference of opinion.

For the present it seems worth while to emphasize more sharply than heretofore the distinction between public health measures of proved value and those that owe their existence to tradition or to misdirected and uninformed enthusiasm. Further study of the results obtained by certain of the usual and conventional health department activities is also much needed, and as a preliminary to such study the proper collection and handling of vital statistics is essential. It is poor management and unscientific procedure to continue to work blindly in matters pertaining to the public health, to employ measures of whose real efficiency we are ignorant and even to refrain from collecting facts that might throw light upon their efficiency.

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THE ENGINEERING SCHOOL GRADUATE: HIS STRENGTH AND HIS WEAKNESS[1]

So much has been written and spoken of late concerning the success or failure of the various engineering courses in our schools of technology that a reason should be offered for the introduction of this topic at this time. It is to be found, I think, in the general and increasing interest in these matters which is leading the practising engineers, the manufacturers, the men of affairs, in short, the consumers of the product of the engineering schools, to examine and evaluate the work of these schools. This interest has voiced itself more and more freely in the daily press, the engineering journals, and the occasional address. Some of the comments thus made are harshly critical, some are based upon sadly insufficient knowledge of existing conditions, but many are sane and helpful. It is the duty of those of us who are charged with the conduct of those courses to give heed to these utterances and to avail ourselves of the helpful counsel which many afford, but it is also a privilege which we may sometimes allow ourselves to present the case as it appears to us, and this anniversary occasion seems to suggest both retrospection and introspection.

The complexity of the educational problem is nowhere greater to-day than in the training of the engineer, using that term in a broad sense to include the man who applies his science to concrete ends, whether he be, for example, civil engineer, research chemist, or field geologist. The boundaries of all the sciences have been extended at a rate which has far outstripped any reasonable alteration of educational methods to meet these changing conditions, for, over against the charge of undue conservatism which is commonly made with respect to educational practises, should be placed the fact that seven years is the minimum period which must elapse before the ultimate success or failure of an educational experiment can be determined, and since the remodeling of a course or system of

[1] Presented before the Congress of Technology at the fiftieth anniversary of the granting of the charter of the Massachusetts Institute of Technology.

instruction to utilize successfully such of the newly acquired knowledge as it is possible to include must often be the result of gradually accumulated experience, it is plain that rapid and frequent alterations are both unwise and unprofitable. Such advances in scientific knowledge as, for example, those relating to wireless telegraphy, the turbine engine, or aeroplanes, which are of such immediate significance as to seem to imperatively demand a place in our courses of instruction, can not be allowed to displace other older topics of permanent importance, and in many cases these later developments of science are based upon abstruse principles, the proper teaching of which, in turn, demands much time.

The educational problem has, moreover, been rendered more difficult of solution by the concomitant increase in the number of men to be educated. It is no longer possible to give to the undergraduate that measure of personal attention from a mature teacher, of strong personality, which characterized successful teaching in the young manhood of our fathers, and resulted in the production of what may be termed "hand-made engineers." And, again, the increased ease with which our young men can now obtain educational advantages is sending to our schools a much larger proportion of students who, while they are earnest to a high degree and constitute a most desirable class of pupils, have not descended through generations of ancestors with scholarly or scientific instincts, and have not been surrounded by an atmosphere which is at all closely in harmony with that of the lecture room or laboratory. That most of these young men meet with success is the more to their credit, that some others meet with only measurable success in the scientific professions, and that distinct limitations, both professional and social, manifest themselves in the post-graduate development of some, is not surprising, but the cause is often mistakenly ascribed to faulty educational methods when in truth it is far more a question of raw material than of manufacturing process.

The product of the engineering schools has not escaped the universal demand that all products should advance in quality without increase in cost, which, in this instance, means with little or no increase in time expenditure. One needs only to review the conditions of the last quarter-century to realize that an extraordinary change has taken place in the position of the engineer in the community. None of the older professions have been called upon to face such kaleidoscopic conditions and it is not strange that there should be a dearth of men immediately adapted to meet the altered situation, or that many should be found to be partially lacking in the extremely composite training which would lead to complete command of the field. It may not be irrelevant to ask whether the so-called learned professions, so long regarded as superior to the engineering professions, would have fared distinctly better under a like extreme test.

The wholly successful engineer of the day (I do not speak now of the recent graduate) must be a man possessing a capacity for logical, quick and exact thought, a detailed knowledge of some portion and a broad knowledge of the whole of his professional field, and be master of a certain amount of the technique of his profession. He must have the ability to select and guide competent and trustworthy associates and to obtain from them loyal and willing service. He must be strong in his sympathies and generous in his public services, and while quick to enlist desired interest in his enterprises he

must be shrewd in detecting avarice or perfidy He should be a loyal husband and father, and should find opportunity for that enjoyment of art and literature which will afford him present pleasure and ensure the happiness of advanced years It is a matter for sincere rejoicing that the engineering profession has reached such a commanding position in our national life that only a man of this type can completely fill it, but the imperfect portrait just drawn is evidently that of a man for whom nature must have done much at the start, and toward whose efficiency many elements must have contributed Of the need of such men there is no doubt, and it becomes a question of paramount importance to ask how far the engineering schools, as such, or, indeed, how far our entire educational machinery, can contribute to the desired end The most obvious function of the engineering school is to afford a fundamental knowledge and understanding of the principles of the sciences underlying engineering operations Failure to do this seems to be without excuse, yet it is almost inseparable from another important function, namely the development of the power to think (for there can be no adequate understanding of principles unless one can think logically in terms of them when considering concrete problems), and it is just at this point that much of the current criticism is aimed The candid teacher must admit that there is truth in the charge that the graduates are too often lacking both in a capacity for logical thought and in an ability to command the knowledge which they actually possess to the degree needful for immediate or perhaps ultimate success in their vocation. But it should not be supposed that he is indifferent to this state of affairs. It is within bounds to say that it is the supreme desire of every worthy teacher to encourage power of thought rather than mere acquisition of knowledge on the part of his pupils and that he is constantly devising and testing new means to that end, but a moment's consideration will show you how much this depends upon personal contact —now so difficult in even the smallest practicable subdivisions of large classes—and will convince you that there must also be constant conflict of judgment as between the extent of the field to be covered in a given subject (rarely more than the minimum quantity now-a-days) and the time which can properly be spent in that drill which is necessary to develop the powers of the average student, for it is against the average student that the criticism is most valid I do not make these statements to condone the conditions but rather to show you that the teachers recognize them, deplore them, and are striving against them, but the contest is an unequal one, at best.

Let it be remembered, moreover, that some responsibility for these conditions rests upon our public-school system, and also that the sort of thinking which the engineering professions demand is of a kind which is more exacting than is essential in the more common vocations, and that *no* system of education has yet succeeded in training a large proportion of exact thinkers, however much such a result is to be striven for Let us also admit for our encouragement that, after all, there is a considerable proportion of our engineering graduates who *can* use their brains effectively and do have their knowledge in available form, and my observation leads me to believe that there is a much larger proportion who appear deficient in these respects at graduation who develop unexpected power when they have opportunity to concentrate their efforts in a more limited field. Remember that many of these youths have been in some sort of educa-

tional training for a continuous period of fifteen to seventeen years, during which there has been a constant (but sometimes unwise) increase in the pressure put upon them to cover more ground. Is it strange that they have lacked an opportunity to sort their immense stock, or to become familiar with it? They are, I think, entitled to charitable consideration for a time after entering their vocation, but if, as a class, they are deficient after three years, the criticism of them or of their training certainly becomes valid.

The public has a right to look to the engineering schools for sound instruction in fundamentals, including, of course, physics and chemistry, as well as the mathematics and drawing which must form a part of the equipment of every competent engineer. In addition, they may demand that the fundamental principles and something of the technique of those subjects which are of general application within a given profession shall be thoroughly taught, and that this shall be done with reference to development of power and the inculcation of useful habits, rather than the mere acquisition of information. While this is a demand which no engineering school would desire to evade, let us recognize that it is, of itself, no light task to accomplish.

But in our epitome of the distinctly successful engineer of maturer years was included *breadth* of knowledge within and without his profession, the quality of leadership, which means power of initiative and a knowledge of men, and the ability and inclination to fulfill the requirements of good citizenship. Are the graduates from the engineering schools, as a class, in line to develop thus symmetrically? Let us admit again that many are not and that that is the occasion of the general charge of "narrowness" and inadequacy which is directed against our courses. But here again I venture to assert—not, however, in a spirit of complacency—that the situation is more complex than is generally admitted, and that there is a good deal that is encouraging in the situation. Recall once more how short a time it is since the engineer has occupied a position in the community which is recognized to be of equal dignity with that of the so-called learned professions, and recall how recent is that evolution of our industrial system which has as its most important feature the recognition of the fact that the engineer and the financier, if not combined in the same individual, must be on a parity with respect to influence and authority, if efficiency—the watchword of the hour—is to result. Is there not cause for congratulation that some have been found in the engineering ranks capable of meeting this surprising increase of responsibility rather than ground on which to pronounce the general result of engineering education a failure, as some seem inclined to do?

It is well known that the Massachusetts Institute of Technology endeavors to stand to-day, as it has from its beginning, for the largest measure of breadth of training and education which is compatible with thoroughness of fundamental scientific instruction. An inspection of its courses as prescribed for the various professions shows that, notwithstanding the pressure resulting from the growth of science and technology, about one eighth of the total hours which a student spends at the institute is devoted to subjects which are cultural studies, using that term to distinguish them from those scientific subjects which may be regarded as tools of trade, although many of these, notably such as physics, chemistry, biology or modern languages, if properly taught, will contribute much to the cultural development

of the well-rounded engineer and the useful citizen outside of his strictly professional field. In this respect the institute has been a pioneer in engineering education and its founders took a position far in advance of the times Nevertheless the Institute has not escaped the charge of narrowness and this has sometimes come, alas, from some of her own sons who were not over-zealous in availing themselves of the opportunities actually offered during their student days More specifically, as has already been implied, it is charged that the graduates from engineering schools are not as a class showing themselves capable of development into men who can occupy successfully the commanding positions already described, and again the institute is not exempted So far as this charge relates to breadth of view within the professions it is the immediate and vital concern of these schools So far as it relates to those traits which go to make up the accomplished man of affairs it is serious, and demands earnest attention, but the remedies are less obvious, for these remedies must mean the superimposing upon an already heavy burden, a task which should be begun in the home and largely completed there, a task, indeed, which no college has satisfactorily met with respect to all of its professional or non-professional graduates So far as books can help, an added year of student life would seem to afford a remedy and there has been much discussion of the desirability of extending the undergraduate course to five years, and of making the engineering schools graduate schools The arguments can not be reproduced here, but it seems clear that the added expense incurred and the increased age at which the young man enters his life work, militate seriously against the adoption of either of these as a universal procedure. For those to whom such opportunities are open they are likely to prove of great value, and it is interesting to note that each year seems to bring to the engineering schools a larger number of young men who have already graduated from some college, and encouragement is also to be found in the fact that more and more of these men have planned their courses during their college years with reference to later work in the technical school, a procedure which is much more to their advantage than what Professor Jackson refers to as a "butt-joint" between a general college course and a later engineering course It should also be remembered that this is a recent educational development and that these men have not yet been tried out

One serious difficulty which technical schools are encountering has been frequently referred to by recent writers, but deserves a mention here, namely, that of securing and holding broad, cultured teachers Specialization has seriously invaded the teaching profession, especially in scientific lines where the mastery of any large field of knowledge to a degree corresponding to the needs of the expert is rarely possible. The specialist is apt to use the microscope far oftener than the field glass and this habit is partially reproduced in his students. It is encouraging to note that certain schools are now recognizing the need of men who are efficient teachers with a broader outlook, to deal especially with the younger men. They are recognizing that not every eminent specialist or successful investigator is a successful teacher, more particularly in this very matter of breadth of view, and are leaving the specialists greater opportunity for the presentation of their specialties to the older classes, while improving the instruction in the more general courses. It is obvious that these difficulties are enhanced by the larger financial rewards which tempt the broad-minded

engineer away from the schools—a serious matter which can not further be discussed here but lies close to the root of much of the cause for criticism. It is interesting to note how even a single instructor, who keeps himself and his pupils closely in touch with current events, and leads them to understand that no single human attainment, however complete or final it may appear, necessarily represents the best that can be done, and that it may well be the privilege and the duty of any one of his hearers to extend the boundaries of such attainment, will give an impetus to successful effort that will be felt in the entire lives of his pupils. It is to be hoped that no one of us is unable to recall with gratitude some such instructor. We need more of them. A single instructor, again, who exemplifies the cultured scholar and gentleman in ease of manner and grace of diction does more for the cause of scholarship and culture than any quantity of sound advice can do, for, I fear that it is utopian to hope that a majority of the students with whom the study of engineering is the main purpose will ever believe that any man is disinterestedly sincere in his advice regarding such subjects as literature, language, art or economics, unless he makes it quite clear to them that these subjects have a distinct significance to him and are a part of his life. Just here lies one of the great obstacles to the elimination of "narrowness."

If the inculcation of breadth of view and love of the refined in life is difficult, the development of qualities of leadership is even more so. That these qualities are largely conferred at birth will, I suppose, be generally admitted, but I take it that the criticism of lack of leadership is really directed toward an alleged culpable lack of facility in getting the best from others, of appreciating the point of view of others, or of presenting our own views to others. If this indicates a failure on our part to stir the ambitions of our students to avail themselves of opportunities which come to them, or to plan for themselves a really worthy career, then we are at fault, but if it means that the faculties of engineering schools should further encourage those forms of activity commonly designated as "college life," then I believe that we are on debatable ground. Of the importance of those traits which enable a man to win the confidence and respect of his fellow men, to "succeed" among men, no one could be more conscious than I. In individual cases they may indeed be more potent factors than accuracy of scientific knowledge in securing preferment, and any man is fortunate who combines engineering skill with ease of manner and persuasive speech. But the real function of these schools is, after all, the training of capable engineers and it is very easy to pass the line beyond which there is grave danger that both the quantity and quality of individual attainment will be lowered because of time and energies devoted to social affairs. By all means let the schools realize their responsibilities for the development of men as well as engineers, and encourage by precept and especially by example an interest in all that tends toward a better understanding on the part of our students of their human relations, including prudent encouragement of the so-called "student activities." But let those who lack a realization of the great changes which the student life at our technical schools has already undergone in the last few years, and who therefore constantly clamor for more of what is called "college life," reflect that one of the greatest assets which a graduate from one of these schools can take with him when he leaves it is the well-established habit of "doing a

day's work in a day," of meeting his obligations on time, and let him realize that this can not be reasonably demanded if the instructors must in fairness accept excuses because of an undue diversion of time and energy to other things. Although the sciences actually owe many of their advances to "grinds," it is probably fortunate that few of our engineering graduates of to-day belong to that class, but there is little likelihood of an undue increase in the proportion of such over-developed scholars under existing conditions! An impartial survey will, I believe, show that our recent graduates are, as a body, less open to the charge of lack of adaptability, and want of social resources than formerly and that they are improving in this respect as the need of such improvement is more generally realized, and also that there is ground for the belief that this has so far been accomplished without serious sacrifice of professional efficiency.

In what I have just said I have had in mind particularly the business and social relations of the young engineer with his colleagues and superior officers. It is often stated that some or many of the graduates also lack an appreciation of the proper way to deal with those whose labors they must direct. This, again, is doubtless in some considerable measure true, and in fact it can hardly be otherwise when nearly all of these young men pass directly from the public schools to the higher educational institutions. It is not, however, true that no effort is made to bring this phase of their future responsibilities to their notice, for not only is the subject discussed in its general aspects from the lecture platform, but the young men are advised to secure summer employment as far as possible to the end that they may learn to know industrial conditions.

In this connection I should like to point out to those in control of our industrial establishments that there is a large store of energy, combined with a desire for opportunity to work and ability to render intelligent and willing service, which goes to waste in the summer because our students are unable to secure temporary positions. This is particularly true in the industries into which the men in whom I am especially interested, the chemical engineers and chemists, will go. I am, of course, aware that the net return in value to a concern from this temporary service is not relatively large, especially during the first summer, and that in certain industries there is a risk in trusting to the integrity of these men with respect to information acquired regarding operating methods. But I can not avoid the conviction that if the industrial managers would cooperate with the engineering schools in the consummation of an arrangement whereby young men whose ability and character could be vouched for could be given summer employment for two or three of the successive summers intervening during the four years of study, the concerns thus cooperating would actually find that they would derive appreciable benefit from the plan. That it would enable the schools to add at least fifty per cent. to their efficiency so far as these students are concerned, I have no question whatever, and surely no better means could be afforded for the acquisition of a knowledge of the problem of the laborer in the works. Let me add that I do not urge the placing of these young men at once in positions of responsibility but rather in such positions as will afford them working experience under industrial conditions. It seems to me, however, that it is not improbable that, say, in a third summer the majority of such men might be utilized to much advantage in the immediate direction of specific processes or operations,

they themselves acting under general or specific direction.

Some of us are just now concerned to know how with respect to chemical engineering we can give the young men an opportunity to come into contact with the actual practise of their profession before they leave the school, and the advisability of the equipment of laboratories of chemical engineering is under careful consideration. While it is no doubt true that, from its nature, chemical engineering offers less abundant opportunities for industrial work during the vacation interval in a student's career than many other professions, notably less than civil engineering, and at the same time is a profession the actual practise of which it is exceedingly difficult to reproduce in an educational plant, I suspect that similar general conditions exist in other lines. Here, again, is a problem with no small dimensions or importance with which we are wrestling, and one step toward its solution may be made through the greater cooperation on the side of the industrial managers for which I have just appealed.

If I have dwelt more upon the alleged weaknesses of the engineering school graduates than upon their strength, it is because the latter is attested by the engineering advance of the recent past to which they have contributed to an extent which would not have been possible had not the majority of them received from the schools an education and training which has proved useful, dependable and stimulating.

I believe that the large majority of the engineering school graduates are virile, intelligent, industrious fellows, with sound habits of thought and great capacity for work, ambitious to make the best of themselves, possessing a sincere desire to acquit themselves honorably, both in private and public life and with an increasing ability to do so. As such, we, their instructors, honor them and ask your cooperation, advice and encouragement in our efforts to give to them what they deserve at our hands. We ask you also to recognize that while for the moment the rapidly changing social and industrial conditions may have outrun our ability to adapt our educational practise to them, we are not lacking in an appreciation of the significance of these changes, or of our obligations for the future.

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CHRISTIAN ARCHIBALD HERTER

THE death of Dr. Herter on December 5, 1910, terminated a life of only forty-five years, a life which had been rich in endeavor and was synonymous with the conception of intellectual cultivation as the happiest outcome of temporal existence.

Dr. Herter graduated from the College of Physicians and Surgeons in 1886 at the age of twenty-one and in the same year married Miss Susan Dows, who throughout his career sustained him with sympathetic power and intelligent appreciation of the value of his work. After graduation he studied with Welch in Baltimore and with Forel in Zurich. He then began to practice medicine, specializing in the diseases of the nervous system, on which subject in 1892 he published his first book. His mind, which was ever active, did not permit him to receive his knowledge through second-hand sources, and in 1893 the upper floor of his house was converted into a series of laboratories in which work could be accomplished according to his liking. It was the beginning of the "Laboratory of C. A. Herter," the contributions of which are known throughout the world. To appreciate the significance of all this, it should be remembered that with the exception of the work in the pathological laboratories of the colleges, the work of the board of health, and the work done by Dr. Meltzer, there was practically no scientific

investigation in medicine worthy of the name in New York city at that time What was true of New York was essentially true of the country at large Here then was one who combined the practice of medicine with the science of medicine as few men of his generation in this country had done Failing strength in his later years caused him to relinquish entirely private practice and devote himself to his laboratory as the center of his intellectual activity It was interesting to note the attitude of an audience when Herter spoke. To many, he was one of them, a practitioner of medicine, and yet to all he was one who had carried medical science to a higher plane, had enveloped medical doctrines with new authority, and the clear, incisive words as they flowed from his lips were followed by his listeners with attentive and almost reverent regard

Dr. Herter found the study of the nervous system so abounding in confusions that he soon turned his attention to chemical problems, especially those connected with pathological conditions Among those intimately associated with him in this work have been E E Smith, A J Wakeman and of late H. D. Dakin Dr Herter's work included researches concerning uric acid, autointoxication, the toxic properties of indol, uremic intoxications, the production of serous atrophy of fat, nitrifying bacteria, acidosis, adrenalin glycosuria, gall-stones, bacterial infections of the digestive tract, intestinal infantilism, the influence of dietary alterations on the types of intestinal flora, and the action of sodium benzoate on the human body The last-named piece of work was part of an investigation conducted by a commission appointed by President Roosevelt, and conclusively demonstrated, so far as physiological investigation can demonstrate, that sodium benzoate if given in the quantities in which it is used as a food preservative, is harmless.

Between 1897 and 1902 Dr. Herter was professor of pathological chemistry at the University and Bellevue Hospital Medical College. Although the lectures were optional, the room was always crowded and his hearers carried away with them breaths of real inspiration. The lectures were published in book form and were translated into Italian In 1903, he was called to the chair of pharmacology and therapeutics at the College of Physicians and Surgeons, a position he held till his death.

He was trustee of the Rockefeller Institute and a moving spirit in the creation of the Rockefeller Hospital Only in the last days of his life was he permitted to see this wonderful hospital accomplished, the dream of many years realized, and almost daily as his strength permitted he would be taken thither to rejoice in its work and its future

He founded the *Journal of Biological Chemistry*, the first of its kind in the English language, and his friends have united in the endowment of this journal as the most fitting memorial to his life's work

Two Herter lectureships, one at the University and Bellevue Hospital Medical College, the other at the Johns Hopkins Medical School, were founded by Dr and Mrs. Herter, and have served to bring to this country many of the greatest scientists in Europe. This has been the public service of a far-seeing mind.

Herter had a wide-spread acquaintance among the scholars of his time both in Europe and at home, and his work and worth were universally respected and admired He delighted in the friendship of those who could inform him, he was a true councillor of those who went to him for advice, and he encouraged young men The blood of the true artist was his Music and painting contributed to the pleasures of his life His friends loved him and he loved his friends GRAHAM LUSK

SCIENTIFIC NOTES AND NEWS

AT its annual meeting on May 10, the American Academy of Arts and Sciences voted to award the Rumford premium to Professor James Mason Crafts "for his investigations in high temperature thermometry and the exact determination of new fixed reference points on the thermometric scale"

THE Academy of Natural Sciences of Philadelphia has elected as correspondents the following: David Starr Jordan, Edmund Beecher Wilson, Jacques Loeb, William Bullock Clark and Thomas Wayland Vaughan.

A complimentary banquet to Professor H. E. Armstrong, F R S., took place at the Hotel Cecil on May 13, attended by a number of distinguished chemists and over two hundred of his former students

At the annual meeting of the British Iron and Steel Institute the Bessemer gold medal for 1911 was presented to Professor Henri Le Chatelier, of Paris The Carnegie gold medal was awarded to Mr Felix Robin, who has conducted researches on the wear of steels and their resistance to crushing Carnegie research scholarships have been awarded to Messrs. W. M. Guertler, of Berlin, G Hailstone, of Birmingham, R M Keeney, of Colorado, and G Dietrich Rohl, of Freiberg Messrs J Newton Friend, of Darlington, and T Swindon, of Sheffield, have had additional grants made to them to enable their researches to be extended and completed

The Association of American Physicians, at its meeting in Atlantic City, elected Dr J George Adami, Montreal, president and Dr Lewellys F. Barker, Baltimore, vice-president

The annual general meeting of the Society of Chemical Industry is to be held in Sheffield on July 12 Dr R Messel has been nominated as president, and Sir William Crookes, F R S, Dr G G Henderson and Messrs H Hemingway and W F Reid have been nominated as vice-presidents

Professor Charles Derleth, dean of the College of Civil Engineering of the University of California, has been elected president of the San Francisco Association of the American Society of Civil Engineers

Dr Francis H Slack, of the University of Kansas, Lawrence, formerly director of the Boston Bacteriologic Laboratory, has been offered the secretaryship of the Boston Board of Health

Dr L. D. Swingle, of Nebraska Wesleyan University, has been appointed research parasitologist in the Wyoming Agricultural Experiment Station

Dr Burt G. Wilder, who last year became emeritus professor of neurology and vertebrate zoology at Cornell University, will hereafter live in Brookline, Mass, where he was born in 1841

Dr F P Gulliver, of the Geological and Natural History Survey of Connecticut and secretary of the section of geology and geography of the American Association for the Advancement of Science, is recovering from a somewhat severe operation that he underwent on May 17

Professor Ernst Haeckel, of Jena, now in his seventy-seventh year, broke his hip bone recently, while standing on a stool to obtain a book from a library shelf

Dean H C Price and Professor W R. Lazenby, of the Ohio State University and Agricultural Experiment Station, have been granted leave of absence for next year, the former for study in one of the German universities and the latter for travel and the study of forestry in Europe and South America

For the year 1911–12 the following will be absent on leave from the University of California: R T Crawford, associate professor of practical astronomy, and G. P. Adams, assistant professor of philosophy. Leave of absence for the first half-year has been given to A C. Lawson, professor of geology, R O. Moody, assistant professor of anatomy; C A. Noble, associate professor of mathematics, and E. E Hall, associate professor of physics; for the second half-year, to D N. Lehmer, associate professor of mathematics.

Professor J. W Beede, of the University of Indiana, will continue his studies of the Permian problem in Oklahoma the coming summer. The work, which will be under the direction of the Oklahoma Geological Survey, will consist in the endeavor to trace the Pennsylvanian-Permian contact from southern Kansas across Oklahoma as far as the Arbuckle Mountains.

Dr Henry Head, F.R S, will deliver the Croonian lectures on "Sensory Changes from Lesions of the Brain" before the Royal College of Physicians of London on June 13, 15, 20 and 27.

EIGHT lectures on the Hitchcock Foundation, at the University of California, were delivered by Professor Harry Fielding Reid, of the Johns Hopkins University, on the evenings of March 28, 29, 30 and 31, and of April 3, 4, 5 and 6 The general title of the course of lectures was "The Mechanics of Earthquakes."

THE annual public address before the chapter of Sigma Xi in the University of California was delivered May 11, by Sir John Murray on the subject of "The Floor of the Ocean" The lecture was illustrated with a fine series of lantern slides largely based upon the results of the Atlantic Expedition of the Norwegian fisheries steamer *Michael Sars* in the summer of 1910

ON the evening of Friday, May 12, Professor G J Pierce, professor of botany in Stanford University, lectured before the society of Sigma Xi of Indiana University on "Vegetation and Civilization"

PROFESSOR ROSS C PURDY, of the ceramics department of the Ohio State University, was recently elected president of the local chapter of the Sigma Xi Society Professor Charles S Plumb was elected vice-president and Professor E F Coddington, secretary

PROFESSOR WAYLAND MORGAN CHESTER gave an illustrated lecture before the departments of geology and biology of Colgate University, on May 25 His subject was "The Bermuda Islands and their Life"

A MONUMENT has been erected at the National School of Agriculture, Montpelier, France, in recognition of the work of the late Gustave Foex, a former president of the school, in improving the culture of grapes

THE Carnegie Fund Committee of France recently awarded the foundation gold medal to the widow of the French doctor, G. E. Mesny, who died while engaged in treating plague victims at Harbin, China.

MRS. WILLIAMINA PATON FLEMING, curator of astronomical photographs in the Harvard College Observatory, died on May 21, aged fifty-four years.

NATHANIEL WRIGHT LORD, for thirty-one years professor of mineralogy and metallurgy, director of the school of mines and first dean of the college of engineering of the Ohio State University, died at his home on May 23, aged fifty-five years

THE New York assembly passed on May 22 the bill previously passed by the senate incorporating the Carnegie Corporation of New York The incorporators mentioned in the bill are Andrew Carnegie, Elihu Root, Henry S Pritchett, William N Frew, Robert S Woodward, Charles L Taylor, Robert A Franks and James Bertram Its purposes are defined as follows "To promote the advancement and diffusion of knowledge and understanding among the people of the United States, by aiding technical schools, institutions of higher learning, libraries, scientific research, hero funds, useful publications, and by such other agencies and means as shall from time to time be found appropriate therefor

THE gentlemen's conversazione of the Royal Society was held at Burlington House on May 10 The fellows and guests were received by Sir Archibald Geikie, K C B, president of the society The Hon R J. Strutt gave a lecture on the afterglow of the electric discharge and on an active modification of nitrogen, and Mr Joseph Barcroft lectured on adaptation to high altitudes in relation to mountain sickness There were as always a large number of interesting exhibits

ADVANCED students or teachers of zoology or botany desirous of working at the Bermuda Biological Station for Research for a few weeks this summer should communicate at once with Professor E L Mark, 109 Irving Street, Cambridge, Mass.

THERE is a vacancy in the Bureau of Soils, United States Department of Agriculture, at Washington, D. C., for the position of soil scientist in the laboratory of physical and chemical investigations. The government is endeavoring to secure the best qualified man available for this work and has no particular individual in view. The position requires a high order of scientific training, equivalent to that required by the leading American universities for a professorship in physical chemistry. As the work will also be largely ad-

ministrative in character, a wide and successful experience in an executive capacity is very essential. A broad field exists for scientific work of a high grade and for original research and investigation which offers rare opportunities for the making of a reputation and for a career in the public service. It is customary to publish the results of investigations in government publications with the name of the scientist making the study or investigation. Those persons who are qualified and who wish to be considered for this position are invited to submit for consideration a statement of their qualifications, references to their published works, and other pertinent material to the United States Civil Service Commission, at Washington, D. C. In general, the methods of procedure in filling this position will be similar to those of an educational institution, whose boards of trustees or governing officers desire to fill professional or technical positions. The qualifications and fitness will be determined by an impartial board of scientists. As the selection for this position will be made about the middle of June of this year, it is suggested that persons interested communicate with the United States Civil Service Commission, at Washington, D. C., at an early date. The entrance salary for this position is $3,000 per annum.

The Health Officers' Association of New Jersey, adopted a constitution and closed its charter membership on May 24, at a dinner and meeting held at Newark. Thirty-three health officers, inspectors and members of local boards of health were present and the association had as its guests two members of the State Board of Health, Col. G. P. Olcott and Dr. R. C. Newton, also Dr. A. C. Hunt, chief of the division of medical inspection; Dr. R. B. Fitz-Randolph, chief of the food and drugs division, Mr. George W. McGuire, chief of the dairy division, and other representatives of the executive staff of the State Board of Health. The objects of the association are the advancement of knowledge relating to the public health, and the promotion of social intercourse among health officials. Five regular meetings in the year are provided for, to be distributed through the winter months. The active membership includes as eligible employees of the state and local boards of health (i. e., health officers and sanitary inspectors), licensed by the State Board of Health, or of the equivalent grade. Members of the state and local boards of health are eligible to associate membership. The officers, elected at a previous meeting, are as follows: *President*, Chester H. Wells, health officer, Montclair, N. J., *Vice-president*, John O'Brien, Jr., health officer, Plainfield, N. J., *Secretary-Treasurer*, J. Scott MacNutt, health officer, Orange, N. J., *Chairman of the Executive Committee*, Dr. Edward Guion, health officer, Atlantic City, N. J.

In 1880 gold was produced in Alaska to the value of $20,000. In 1909 the amount mined was valued at more than $20,000,000. In 1888 silver was first produced in Alaska, to the value of $2,181, in 1909 the value was $76,934. In 1902 copper was first produced, to the value of $41,400, in 1909 its value reached $56,211. These and other statistics of production are shown by Alfred H. Brooks, of the United States Geological Survey, in "Gold, Silver, Copper, Lead and Zinc in the Western States and Territories," published as a separate chapter of the volume "Mineral Resources of the United States in 1909." The Alaska Yukon placer district had in 1909 the most profitable season since mining first began there, a quarter of a century ago. According to the Geological Survey's returns the value of the gold output was $11,580,000, as compared with $10,323,000 in 1908. The production in Seward Peninsula fell off, owing to the facts that many of the richest placers have been mined out and that no preparations have been made for mining the extensive deposits of low-grade gravels. With the construction of large plants an increase may be looked for. The great possibilities of the Alaskan gold-bearing gravels can be recognized when a comparison is made of the recovery from the placer workings of the territory and those of the United States. In 1909 the average recovery for Alaska was $3.66 a cubic yard, while for the United States the recovery was only 12 cents.

UNIVERSITY AND EDUCATIONAL NEWS

MR. T. C. DU PONT has given $500,000 to the Massachusetts Institute of Technology toward its proposed new site. Announcement is also made of two bequests of about this amount: a trust fund of between five hundred and six hundred thousand dollars, created by Francis B. Greene some five years ago, will be received by the institute for the assistance of students, and it will receive nearly $500,000 from the bequest of Mrs. Emma Rogers, widow of William B. Rogers, the first president of the institute. These large gifts in addition to the $100,000 for ten years appropriated by the state, will make it possible for the institute to purchase a new site and erect the necessary buildings.

BY the will of Mrs. Lydia Augusta Barnard, of Milton, Mass., Radcliffe College received $75,000 for a dormitory and $40,000 for scholarships, and Harvard University receives $60,000 for the study of jurisprudence and legislation.

THE Harvard College corporation has voted to approve the establishment of a school for advanced instruction in medicine in general accordance with a plan proposed by the Faculty of Medicine, the intention is that the school shall go into operation at the beginning of the academic year 1912–13, that it shall have a separate dean and administrative board, and that it shall ultimately absorb the Summer School of Medicine. Instruction in the school is to be provided if possible by the existing departments of the Medical School, but, if necessary, instructors will be appointed specifically for giving instruction in the new school. The courses of instruction will consist of all-day courses, intermittent courses and research courses.

THE preamble of the statute exempting students in natural science and mathematics from examination in Greek passed congregation at Oxford on May 16 by a vote of 156 to 79.

PLANS for the extension of the work of the department of physiology of Columbia University are being carried out. Three additions to the staff have been made: Frank H. Pike, of Chicago University, to be assistant professor; Horatio B. Williams, of Cornell, to be an associate, and Donald Gordon to be an instructor. Dr. Williams is spending the summer in Europe visiting several laboratories and arranging for the purchase of apparatus for electrocardiographic and other work. Professor Burton-Opitz will have charge of the instruction of the medical students and Professor Pike of much of the work in general physiology. A course in clinical physiology, dealing with the application of physiological methods to problems of clinical medicine has been established. Changes in the laboratories will be made during the present summer. The income of the George G. Wheelock Fund is to be devoted to the extension of the library. The chief professorship of physiology, held by Frederic S. Lee, has been entitled the Dalton Professorship, in memory of John C. Dalton, who was in point of time the first experimental physiologist of America and gave distinguished services to the Columbia School of Medicine for thirty-five years.

DR. S. O. MAST, professor of botany at Goucher College, has resigned in order to accept an associate professorship in zoology in the Johns Hopkins University. He will take up the duties connected with his new position at the opening of the next school year.

AT the University of California J. G. Fitzgerald has been appointed associate professor of bacteriology, J. Frank Darnel, assistant professor of zoology, and A. U. Pope, assistant professor of philosophy. Instructors have been appointed as follows: C. J. Lewis, in philosophy, Frank Irwin and Thomas Buck, in mathematics, C. L. Baker, in mineralogy and geology, D. W. Morehouse, in astronomy.

DISCUSSION AND CORRESPONDENCE

THE TEST OF VITALISM

TO THE EDITOR OF SCIENCE: Such attempted definitions of vitalism as those furnished by your correspondents fail to give a clear conception of the idea usually conveyed by the word. Its real significance, I think, is better

expressed by a hypothetical test. Assume any healthy organic cell or organism to be instantaneously resolved into its constitutent particles so that they are suddenly reduced to inorganic substances Then assume that it were possible to instantaneously reassemble each of these particles in precisely the physical relations in which they before stood to each other with the same temperature conditions and let each particle be instantaneously impressed with motions the same in direction and amount which they possessed at the instant of dissolution If then the reassembled body goes on as an organism as before, it will be proof that life is but the operation of what are known as the ordinary mechanical and chemical forces If not, it will be proof that a certain tertium quid no matter what is lacking to convert the body into an organism This tertium quid constitutes the element of vitalism as it is generally understood It does not necessarily imply the imposition of some new and foreign principle or substance on the materials constituting the body It may be nothing more than the bringing into activity of forces or affections previously latent in the materials themselves. The former seems to be the theory of the extreme vitalists who look on the soul as something distinct from the body, while the latter seems to correspond with the views of those vitalists who regard matter as in the language of Tyndal impressed with the potency of all life.

In a last analysis, however, no sharp line of distinction can be drawn between the vitalists of the latter type and the non-vitalists. For it seems clear that if this tertium quid be in any manner latent in the inorganic particles, it may be looked on as undisclosed chemical attributes of the matter itself. It becomes rather a question of definition, what are chemical or mechanical attributes? These terms in their popular significance are confined to forces subject to comparatively simple mathematical laws. I think few mathematicians would concede that such laws, however numerous, could furnish an equation which would satisfy the complicated movements involved in the life history of an organism. The forces at work must be something more than those ordinarily understood as mechanical or chemical.

When to this is added the element of self-direction or self-selection, which in its higher forms assumes the aspect of self-consciousness, we have crossed a barrier which apparently can never be bridged in terms of mechanical or chemical forces and which must seemingly forever remain a mystery, whose solution we are no nearer than were the old Greek philosophers The weight of such evidence as we have seems to favor a modified vitalist or it might be called mechanical vitalistic view All vital activity is measurable in terms of energy expended. An infinite chain of physical causation determines every vital movement. No power of self-determination beyond such causation could exist without the power to create energy. The activity of the organic mechanism may be suspended indefinitely and again revived if no disarrangement of its constituent particles occur On the other hand, no mathematical laws can be conceived of which could express the operation of the forces which direct the life history of the individual Are we not brought back to the old theistic or deistic conception of an inscrutable power pervading all nature in whom we live and move and have our being?

WALTER S. NICHOLS

NEW YORK

A PLEA FOR THE USE OF REFERENCES, AND ACCURACY THEREIN

TO THE EDITOR OF SCIENCE. It has been the writer's duty, during the past two or three years, to compile, or to assist in the compiling of, a number of extensive bibliographies and lists of references to the literature of various chemical subjects, and during this work it has been often impressed upon him with what laxity and apparent disregard of consequences some authors handled—or failed to handle—their references to prior work. The same difficulty is all too often experienced when looking up some apparently simple subject.

For instance, an article was recently desired by a chemist employed in certain synthetic

work, describing a method for the reduction of certain compounds, referred to in a scientific paper, without further information, as "Ladenburg's" method Persistent search of the indices of the journals where the paper would most probably have appeared yielded only a brief polemic note, *which made no reference to the appearance of the original paper!* The proper method was finally found as a side-issue in a paper on oximes, through the use of a very recent hand-book of laboratory methods, the author of which had very probably gone through the publications of Ladenburg until he struck this article Had the author of the paper from which the reference (?) mentioned in the first sentence of this paragraph taken half a minute's more time and given this reference, and given it correctly, he would have saved others literally hours of searching

Another instance. Certain important and excellent work was recently done in Philadelphia on methods of sewage disposal As one feature of this work, a large number of determinations of the amounts of nitrates present were made by what was referred to as "McRae's narcotine test," no reference or description of the method being given. It became necessary elsewhere to find the details of this method, and it so happened that the usual chemical abstract journals had missed this paper. As a last resort, the "Index Medicus" was looked through, and finally a reference to the paper was found, though even here the citation given was not the one where the paper would usually be most easily found Had the author of the report of the Philadelphia experiments given a half-line reference to the place of publication of this method, he would have saved an hour or more of the time of one or two men in a busy laboratory

Fortunately, cases of the total omission of an important reference are comparatively rare, though the embarrassment and additional work such omissions cause is quite sufficient to warrant their being judiciously guarded against. More frequent, and sometimes equally troublesome, are the cases where erroneous page, volume or year numbers are given, or sometimes even an erroneous journal or book name A case recently shown me was that of an author who referred some eight or nine times in a paper of four pages, to the work of another author "Schreiber",—"Schreiber's" correct name was "Fleischer"!

The movement for the unification and coordination of zoologic nomenclature, although differing in many considerable respects from what a similar movement in other sciences would be, includes not a few phases which could well be studied and adopted by non-zoologic contributors to the literature of science.

F ALEX MCDERMOTT

HYGIENIC LABORATORY,
WASHINGTON, D C,
May 11, 1911

A TREMATODE EPIDEMIC AMONG ENGLISH SPARROWS

DURING the months of June and July, 1910, English sparrows in the vicinity of the College of Agriculture of the University of Wisconsin at Madison were found to be very commonly infected with a trematode parasite which was identified as *Monostoma faba* Bremser This parasite, which forms conspicuous cysts in the skin of the abdominal region, has long been known in Europe, but has heretofore been reported in only one or two isolated cases on this continent. Attention is called to the matter here, as it may be of general interest to helminthologists, and in order that others may be on the lookout for the parasite in this country. In this locality the parasite appeared to cause a certain mortality, and it is possible that it may become one of the means which will help to check the increase of the English sparrow in North America. Unfortunately, it attacks other small passerine birds of several families as well. A more detailed account of the present epidemic is being published in the *Bulletin of the Wisconsin Natural History Society*, Vol. 9, Nos 1–2, pp. 42–48, pl. 5, April, 1911

LEON J. COLE

MADISON, WIS.,
April 19, 1911

REFORMED CALENDAR

A CALENDAR project which ignores the immutable character of the week has slight chances of being adopted because the week is fixed by religious observance in all christian nations The calendar here proposed is based on the week as a fundamental unit It is closely similar to the calendar recently proposed by Dr C G Hopkins, but differs in that it consists of a year of thirteen months, each four weeks in length, instead of Dr Hopkins's twelve months divided into quarters of three months, each quarter containing two four-week months and one five-week month Dr Hopkins's reason for retaining twelve months is that the quarters of the year may be even months, but the value of the quarter year as a unit of time is incomparably less than the value of the month It is highly desirable to have all the months the same length for the reason that salaries, wages, rent. board and many other ordinary affairs are counted in months The advantage to be gained by having months of uniform length is one of the most marked advantages to be gained by a reform of the calendar

In the present project the new month is inserted between June and July This is the month in which the summer solstice occurs in the northern hemisphere and the winter solstice in the southern hemisphere, hence it may properly be called "Sol"—the month of the solstice

In the new calendar the quarters are easily found, as each consists of thirteen weeks The four quarters would end on the following dates first quarter, April 7, second quarter, Sol 14; third quarter, September 21, fourth quarter, December 28, and these dates would all be Sunday in the new calendar. The present project therefore contains all the advantages of Dr. Hopkins's project, and the additional advantage of having all the months the same length, as well as multiples of the week

Other advantages of the new calendar are: the year always begins on Monday, every month begins on Monday, the same day of the year always occurs on the same day of the week, the same is true of the days of the month Thus, the first, eighth, fifteenth and twenty-second of every month would fall on Monday, the seventh, fourteenth, twenty-first and twenty-eighth of every month would fall on Sunday.

If desired Sunday may as well be taken as the initial day of the week, month and year

An additional advantage is that a calendar for one year is good for all future time, as the years are all alike in all respects except that every fifth year has an extra week added to December, with exceptions noted below

The details of the project are as follows

Common years consist of thirteen months of four weeks each, namely, January, February, March, April, May, June, Sol (the month of the solstice), July, August, September, October, November and December;

Long years differ from common years in having an extra week added to December,

Years divisible by five are long years, with the exceptions noted below

The extra week is omitted from years divisible by 50 It is also omitted in the year '25 following centennial years divisible by 400, and in the year '75 following centennial years divisible by 25,000. This makes a calendar good for more than 300,000 years

In order to cause less confusion, this calendar should be adopted in a year that begins on Monday In the near future these years are 1912, 1917 and 1923.

In order to secure the adoption of a reformed calendar, we must secure the appointment of an international commission with representatives from all civilized nations. It seems to me that our present duty is to begin a serious attempt to secure the appointment of such a commission Can we not form an organization for this purpose?

W J. SPILLMAN

WASHINGTON, D C.

QUOTATIONS

THE SCIENCE MUSEUM AND THE NATURAL HISTORY MUSEUM

DURING the past few weeks we have printed letters from several distinguished correspon-

dents dealing, from various points of view, with the very serious question that has arisen between the Office of Works and the trustees of the Natural History Museum concerning the respective claims of that museum and of the adjacent Science Museum to what remains still unoccupied of the space which separates the one from the other. No one can think that the buildings in which the Science Museum is at present housed are worthy of the dignity of science, or of their position as associated with the central home of science in the capital of a great empire. Every one should approve, therefore, of the recent appointment of a committee by the president of the board of education to consider the demolition of existing buildings and the construction of a new Science Museum on a scale worthy of its purpose and character. But it would appear from the recently published official correspondence between the Office of Works and the trustees of the Natural History Museum that this committee is only empowered to consider the construction of an enlarged Science Museum on the site now occupied by the unworthy and unsightly buildings which now go by that name. It is clear, however, that this can not be done—for on this point, at any rate, the Office of Works and the trustees are in full agreement—without encroaching on the space required for future enlargements, already urgently needed, of the Natural History Museum, and in fact on space which after much correspondence between the trustees, the Office of Works, and the Treasury, was formally allotted in 1899 to the Natural History Museum for that purpose. In the interest of the new Science Museum the Office of Works now proposes to resume possession of a strip some seventy feet wide and some 1,200 feet long, running the whole length of the north side of the area hitherto allotted to the Natural History Museum. This strip is at present occupied as to some portion of its length by a Spirit Museum—that is, a building for the storage and exhibition of specimens preserved in spirit, 145,000 in number, contained in 95,000 jars, many of large size—which has been erected and fitted up within recent years at a total cost of no less than £38,000. It is now proposed that, as soon as the Spirit Museum has been removed to a new and very objectionable site, a portion of this strip some forty feet wide should be assigned to the new Science Museum, while the remainder, some thirty feet wide, is to be converted into a private road separating the two museums.

It should surprise no one that the trustees should, as they say, view these proposals "with extreme apprehension." The only wonder is, perhaps, that the Office of Works should ever have entertained them seriously. It was originally proposed that the total area to be assigned to the Natural History Museum should be about fifteen and a half acres, and the steady growth of the museum in recent years has shown that this was not a yard too much. By the arrangement of 1899, to which we have already referred, this area was reduced to a little over thirteen acres, and it is now proposed to reduce it by very nearly two acres more, although, as the trustees point out, the reduced area of 1899 was accepted on the understanding that it was their intention to use the land in question for the further extension of the Spirit Museum, and "it can only have been by reason of such understanding that the trustees felt justified in accepting that line of boundary as a final settlement of the question." Yet if the Office of Works is to have its way, that final settlement is now to be treated as no settlement at all. The northern boundary is to be set back by seventy feet; the Spirit Museum is to be abolished and reerected facing Queen's Gate in such a position on the vacant space still surrounding the Natural History Museum as grievously to impair the symmetry and sightliness of any future extension of the latter; and the Science Museum and the Natural History Museum are to be left and even encouraged to approach each other from the north and south respectively in such a manner as may and probably will leave in the end only a private road some thirty feet wide between them. We can hardly believe that parliament and public opinion will ever sanc-

tion these extraordinary and most objectionable proposals. To judge from the correspondence which we have printed on the subject, they appear to find favor with no one—for even Sir Henry Roscoe could only find something to say for them by making a suggestion for the removal of the Spirit Museum to a distant site which other equally high authorities have shown to be inadmissible—and they have elicited protests of unanswerable cogency from naturalists of such high authority as the master of Christ's and Dr. Gilbert Bourne, as well as from the Linnean Society, the Entomological Society, and the Royal Horticultural Society. Moreover, the emphatic protests on other grounds and from other points of view of Lord Wemyss and of Lord Dufferin and those associated with him are by no means to be overlooked.

The plain truth is that, as the trustees put it in their final letter to the Office of Works, "to attempt to accommodate three important institutions, the Natural History Museum, the Imperial College of Science, and a much enlarged Science Museum, on so restricted a site shows a want of appreciation of the inevitable future of these institutions which is bound to lead to confusion and a waste of public money. Not only the Natural History Museum, but all three institutions, would soon be hampered in their growth." The propositions here advanced scarcely admit of dispute. The trustees point out that they have recently been enabled by the government to purchase land at Bloomsbury sufficient to provide for the extension of the departments located there in such a manner as to satisfy prospective needs of those departments for 100 years to come. Yet all that the Office of Works can say on behalf of its unhappy scheme for extending the Science Museum at the expense of the Natural History Museum is that "the vacant space to the east and west of the Natural History Museum is so great that it is hardly possible to suppose it will not afford abundant facilities for any extension of the Natural History Museum which may be required for the next twenty-five years"—which is just a quarter of the period for which the government have empowered the trustees to make provision at Bloomsbury. The comment of the trustees on this significant contrast appears to us to be quite unanswerable. They "feel bound to protest against the reversal at South Kensington of a policy so carefully considered and so universally endorsed"—as regards the departments at Bloomsbury, that is—"and they can not therefore, with due regard to their responsibilities, consent to give up land which will be urgently required in the near future for the extension of the Natural History Museum." To this most reasonable *non possumus*—reasonable because based on indisputable facts as well as on the authority of all competent experts—the Office of Works could only reply by a departmental *hoc volo, sic jubeo,* backed by the authority of the government. "The question of the revision of the boundaries has been considered by his majesty's ministers, and they have decided that such a revision can not be avoided in view of the pressing necessity for the building of a Science Museum." So far as we are aware no one disputes the pressing necessity for the building of a Science Museum. But surely no one who has studied the official correspondence or who has followed the discussion in our columns can defend or approve the policy of building such a museum at South Kensington in such a manner as must fatally hamper its own expansion and that of the Natural History Museum in the near future. There is manifestly no room for all three institutions on the same site. Two of them are there already, therefore the third must go elsewhere. That is the only rational solution of the problem, and it certainly ought not to be rejected by the mere fiat of his majesty's ministers without giving parliament and public opinion an opportunity of pronouncing judgment on the matter.—London *Times*.

SCIENTIFIC BOOKS

The Principles and Methods of Geometrical Optics. By JAMES P. C. SOUTHALL. 8vo. Pp. xxiii + 626. New York. The Macmillan Company. $5.50 net.

Professor Southall, in his book on geometrical optics, undertook to put in one volume most of that which is valuable on the subject, especially as applied to optical instruments He was filled with enthusiasm, inspired by a sincere belief in the value of the subject and an ambition to supply the admitted deficiency in the English language

Partly with the object of supplying this deficiency, and partly also in the hope (if I may venture to express it) of rekindling among English speaking nations interest in a study not only abundantly worthy for its own sake and undeservedly neglected, but still capable, under good cultivation, of yielding results of far reaching importance in nearly every field of scientific research, I have prepared the following work .

It is such enthusiasm as this that holds one to the severe labor of preparing a large book and of making it a good book While it is doubtful whether any large number of scientific men will follow Professor Southall in his very high estimate regarding the relative value of geometrical optics and in his optimism respecting its future, the careful and exhaustive book which he has prepared will undoubtedly do much to bring the geometrical theory of optical instruments into greater favor in this country

Professor Southall treats in successive chapters the fundamental properties of geometrical optics, the properties of rays of light, reflection and refraction at a plane surface, refraction through prisms, reflection and refraction of paraxial rays at a spherical surface, refraction of paraxial rays through thin lenses, the theory of optical imagery, lenses and lens systems, exact trigonometrical formulæ for tracing rays through spherical surfaces and centered systems of spherical surfaces, theory of an infinitely narrow bundle through an optical system, theory of spherical aberrations including Seidel's theory developed to aberrations of the third order, color-phenomena and chromatic aberrations, aperture, and field of view and brightness of images. It is seen from this how extensive is the subject-matter treated. In general, all the chief discussions of the more important topics have been given This has led to a duplication in very many instances; particularly, many subjects are treated both geometrically and analytically This, of course, is not to be regarded as a positive fault in an exhaustive treatise, for the one method will appeal to some and the other method to others. But probably many will wish, on reading the book, that especially the first part had been written more concisely and with fewer repetitions of subject-matter under different forms This would not be, however, in harmony with the obvious plan of reproducing essentially all that is of value in the subject The alternate plan is to adopt a definite point of view and to develop the subject systematically from that point of view

Probably the greatest service rendered by Professor Southall has been in setting forth clearly and consecutively the splendid optical theories of the German writers of the last half century, particularly those of Seidel and Abbe His book may inspire us to divide with the Germans the future developments in these lines At any rate all who have an interest in the subject will thank him that he has so well done his part, for it will not be questioned that he has prepared the best and most exhaustive work on geometrical optics in the English language. So far as the question of completeness is concerned there seems room for regret, and that mostly on the part of practical opticians, only in that the theories are not illustrated more by numerical examples based on the glasses of commerce

F. R MOULTON

A Laboratory Manual of Inorganic Chemistry By EUGENE C BINGHAM, Ph D. (Johns Hopkins), Professor of Chemistry, Richmond College, Richmond, Va, and GEORGE F. WHITE, Ph D. (Johns Hopkins), Associate Professor of Chemistry, Richmond College, Richmond, Va. New York, John Wiley & Sons; London, Chapman and Hall, Limited. 1911. 12mo, pp viii + 147 Cloth, $1.00 net (4s. 6d net).

In the preface the authors state that, in their opinion, "a course in inorganic prepara-

tions and systematic qualitative analysis, with a few carefully chosen quantitative experiments afford the best background for the theoretical development of the science." They have, in order to avoid superficiality, cut the number of experiments down to a minimum, necessary for the understanding of the subject in its elementary phases. They have given more experiments than can be done in the normal year's work in school or college, hoping to stimulate the ambitious student to further work.

They have selected 33 typical experiments which includes the preparation of the common gases and acids and the preparation of several salts. This is followed by a study of the typical reactions of the metals and a course in qualitative analysis. The book also contains a few pages devoted to the quantitative proof of some of the fundamental laws upon which the science of chemistry is based. The material given is well selected and clearly stated, though, as the authors state in the preface, they have introduced little that is new. The question that each teacher must solve is whether it is better to cover a limited field thoroughly or to cover a broad field by selected examples. If a student's knowledge of chemistry is to be gained by one year's work this book could be used no doubt to advantage in connection with a text-book and a course of lectures; but if the subject is to be pursued further each one of the separate fields covered here would have to be gone over again in greater detail in order to attain a suitable ground for more advanced work.

J. E. G.

A Naturalist in the Bahamas. By JOHN I. NORTHROP. October 12, 1861–June 25, 1891. A memorial volume edited with a biographical introduction by HENRY FAIRFIELD OSBORN. New York, The Macmillan Co. $2.50.

The present volume brings together the papers of the late Dr. John I. Northrop, describing the zoological, botanical and geological results of his six months' collecting on the Bahama Islands. It includes also a narrative of the expedition contributed by Mrs. Northrop; a report upon the Bahaman crustaceans by Professor William H. Rankin; on the actinians, by Professor J. Playfair McMurrich; on the shells by Professor William H. Dall, on plants by Mrs. Northrop, Mr. Frank S. Collins and Dr. O. F. Cook, and a paper describing the new oriole *Icterus northropi*, by Dr. J. A. Allen. All of those papers are carefully republished and the volume forms altogether a substantial contribution to American zoological literature. . . One closes the book with the feeling of keen regret that the life of Dr. Northrop could not have been spared. If his early promise brought together both from his own pen and from those of his associates the present results, what may not his years of maturity have contributed? He was another Lycidas and zoologists will remember him with such men as Harrington, Budgett and Balfour.

BASHFORD DEAN

THREE FORMICID NAMES WHICH HAVE BEEN OVERLOOKED

MR. S. A. ROHWER has kindly called my attention to two generic names which have been overlooked by all recent myrmecologists, including Dalla Torre, the author of the "Catalogus Hymenopterorum." One of these names is *Typhlomyrmex*, which was given by Gistel in 1856[1] to *Myrmica typhlops* Lund. On referring to Lund's paper[2] I find that *M. typhlops* is mentioned without a description, and since the insect is certainly not a *Myrmica* in the modern sense and can not be identified from the few notes on its habits (moving in files and carrying isopods), the name must be regarded as a *nomen nudum* and hence without any standing in nomenclature. And since Gistel cites no characters for his genus *Typhlomyrmex* but merely bases it on an invalid name, it, too, is without standing. Mayr, without knowing of Gistel's work, described in 1862 a genus *Typhlomyrmex* for a neotropical ant, *T. rogenhoferi*

[1] "Mysterien der europäischen Insectenwelt."

[2] "Lettre sur les Habitudes de Quelques Fourmis du Brésil, addressée a M. Audouin," *Ann. Sci. Nat.*, XXIII., 1831, p. 113–138.

Mayr. A few other species have since been added. It is clear that *Typhlomyrmex* Mayr is valid and not to be replaced by some other name on account of Gistel's *Typhlomyrmex*, which has not even the status of a synonym.

More serious is the second case which involves *Polyrhachis*, an important genus comprising some 300 known species of paleotropical ants. The name *Polyrhachis* was first suggested by Shuckard in a volume which he published with Swainson in 1840.[3] On page 172 of this work occurs the following sentence: "It is in the first division that we find the stingless genera, namely, *Formica* Linn., *Formicina* Shkd., *Polyergus* Latr., *Polyrhachis* Shkd. and *Dolichoderus* Lund, besides several other yet uncharacterized genera which we shall shortly publish." As Shuckard did not live to give a description of *Polyrhachis* and cites no species as belonging to it, the name is merely a *nomen nudum*. It was, however, either resuscitated or reinvented in 1858 by Frederick Smith.[4] He described some twenty species of *Polyrhachis*, with Drury's *Formica bihamata* as the designated type. In the same year 1858 Gerstacker[5] based a genus *Hoplomyrmus* on an African ant, *H. schistaceus* Gerst., which is clearly congeneric with the forms included by Smith in *Polyrhachis*. As Emery has shown,[6] there is some doubt as to which generic name was first published. Since Smith's paper was read before the Linnean Society in June, 1857, while Gerstacker's was not read before the Berlin Academy till April, 1858, the genus *Polyrhachis* has been given precedence by subsequent writers. Emery has, however, adopted *Hoplomyrmus* as a subgeneric name for a number of species which he groups together as the cohort "Polyrhachides carinatæ."

[3] "On the History and Natural Arrangement of Insects," London.

[4] "Catalogue of the Hymenopterous Insects Collected at Sarawak, Borneo; Mount Ophir, Malacca; and at Singapore by A. R. Wallace," *Journ. Proc. Linn. Soc. Zool.*, II, 1858, pp. 42–130, 2 pls.

[5] *Monatschr. Akad. Wiss. Berlin*, 1858, p. 262.

[6] "Saggio di un Catalogo Sistematico dei Generi Camponotus, Polyrhachis e Affini," *Mem. R. Accad. Sci. Ist. Bologna*, 1896, p. 776 nota.

Speculation on the validity of *Polyrhachis* and *Hoplomyrmus* loses all its significance in the light of Mr. Rohwer's discovery that Billberg in his "Enumeratio Insectorum" published in 1820, a work of which there seem to be only two copies in America, one in the Museum of Comparative Zoology, the other in the library of the Boston Society of Natural History, had many years previously established the genus under another name. In this work on p. 104 we find the following:

"G. Myrma Eg.—Formica ol.
Carinata N. Chaled. Fbr. | Hystrix Eg. 2"
militaris Afr. Aequin. — |

The "Eg" in this citation stands for "Billberg." It is clear that this author cites the two valid Fabrician species *Formica carinata* and *militaris* as representatives of a new genus *Myrma* for what was formerly a portion of the genus *Formica* Linn. Both of these species have long been regarded as *bonâ fide* members of the genus *Polyrhachis*, which, as has just been shown, was not established till 1858. The *hystrix* cited by Billberg is a *nomen nudum*, if it be not the *Formica hystrix* of Latreille and Fabricius, which is in turn a synonym of *Atta* (*Acromyrmex*) *octospinosa* Reich. The "Eg" after the name would seem to preclude this latter supposition. Be this as it may, however, there can be no doubt concerning the two other species, one of which, *F. militaris*, may properly be regarded as the type of the genus *Myrma*. This case seems, therefore, to be quite clear and to require, in obedience to our code of zoological nomenclature, the substitution of *Myrma* for *Polyrhachis*. Although this is a deplorable change, owing to the large number of citations of ants under Smith's generic name, there is, nevertheless, a slight gain in brevity and euphony. I would suggest, however, that *Polyrhachis* Smith be retained as a subgeneric name for the type *P. bihamata* Drury and the small cohort of allied species (*bellicosa* F. Smith, *ypsilon* Emery, *craddocki* Bingham and *lamellidens* F. Smith) which Emery calls Polyrhachides hamatæ. The typical subgenus *Myrma* will replace *Hoplomyrmus*,

since its type, *M. militaris*, is closely related to Gerstacker's *schistacea*.[7] The species of *Myrma* may then be grouped under several subgenera, names for two of which are here suggested for the first time, as follows:

Genus Myrma Billberg (1820) = *Polyrhachis* F. Smith (1858)

1. Subgenus *Campomyrma* subgen. nov.
   = Cohors Polyrhachides camponotiformes Emery
   Type *Polyrhachis clypeata* Mayr
2. Subgenus *Myrma* Billberg = *Hoplomyrmus* Gerst.
   = Cohors Polyrhachides carinatæ Emery
   Type *Formica militaris* Fabr.
3. Subgenus *Polyrhachis* F. Smith
   = Cohors Polyrhachides hamatæ Emery
   Type *Formica bihamata* Drury
4. Subgenus *Hagiomyrma* subgen. nov.
   = Cohors Polyrhachides arciferæ Emery
   Type *Formica ammon* Fabr.
5. Subgenus *Hemioptica* Roger
   Type *Hemioptica scissa* Roger.

A third generic name, *Formicina* Shkd., which has been overlooked, is mentioned in the foregoing citation from the work of Swainson and Shuckard. This citation and the context seem to show that Shuckard accepted *Formica* Linn. in a restricted sense as the equivalent of what we now know as *Camponotus* Mayr, probably with the type *Formica herculeana* Linn., but this is open to doubt since no species is cited. On the same page two well-known ants are mentioned as species of *Formicina*, viz., *F. rufa* Linn. and *F. flava* Fabr. If only the former species had been mentioned, we might have been compelled to change our modern genus *Formica* to *Formicina*, but as Shuckard included also *F. flava* (which is at present *Lasius flavus*) in the same genus, we see that *Formicina* is merely a synonym of *Formica* as used by Fabricius and his contemporaries, possibly *minus* the group now known as *Camponotus*. Under the circumstances I can see no reason to replace any of the modern subdivisions of the old Linnean genus *Formica* with *Formicina* Shuckard.

W. M. Wheeler

[7] According to Emery *schistacea* is merely a subspecies of *militaris*.

ON MUSCOID AND ESPECIALLY TACHINID SYNONYMY

The time seems ripe for a few remarks on this subject. There exists in the superfamily Muscoidea an immense taxonomic field awaiting exploitation, and it is to be hoped that it will attract many able workers imbued with a proper sense of responsibility, for it is at the same time a biologic field of first importance and magnitude as regards arthropod and general invertebrate evolution. Only one caution is necessary to those who would enter this field, as well as to those already in it—and this applies as well to all workers in whatever field—which is to do one's work so thoroughly as to secure absolute finality before drawing positive conclusions. In other words, do not make an unqualified statement before going to the bottom of the matter in hand. Results secured during the past three years have demonstrated conclusively that finality in the taxonomy, and consequently in the synonymy, can not be secured in this superfamily by the off-hand comparison, or even by the most careful study, of external adult characters alone.

Mr. D. W. Coquillett, in his "Revision of the Tachinidæ of America north of Mexico,"[1] without the knowledge just mentioned and thus without any true conception of the great difficulties before him, moreover without a good eye for external characters and with little appreciation of their importance, but nevertheless with the best of intentions, attempted to group these flies comprehensively and indicated extensive but often incorrect synonymy, lumping even distinct genera under one species in the most uncouth but seemingly plausible manner. We can not but admire the industry and ingenuity which have contributed to produce this work, while we deplore its great lack of quality. Dr. J. M. Aldrich, in his "Catalogue of the North American Diptera,"[2] also without the above knowledge but with a somewhat better eye for external characters, though following Mr. Coquillett quite faithfully in the main, has resurrected a few

[1] Techn. Ser. Bull. No. 7, Div. Ent., U. S. Dept. Agr., 1897.

[2] "Smiths. Misc. Colls.," No. 1444, 1905.

species from the latter's synonymy My own publications on the subject, which have been quite extensive and in which I have proposed many new genera and species, no small part of which may quite possibly have to go in the final synonymy, were produced almost in whole without the above knowledge but with a very considerable appreciation of the necessity for a most careful and minute comparison of external characters Brauer and von Bergenstamm's monumental work, performed under the same conditions, and unquestionably the best and most advanced of all, must be classed here too, along with all other taxonomic work in the Muscoidea to 1908 The results in all these cases have been quite unfortunate, considering the amount of time and energy expended All the material handled by Mr Coquillett will have to be restudied with great care in the light of dissections of fresh material from type localities My own types and those of Brauer and von Bergenstamm will have to be restudied in the same manner In fact, all accessible muscoid types the world over will have to be restudied in this new light Here is an amount of work to be done that almost staggers one to contemplate.

Brauer and von Bergenstamm possessed a most acute appreciation of the necessity for searching out even the most minute external characters in order to arrive at the true relationships of the forms They probably carried the study of the external adult characters about as far as it can be advantageously done without correlation with the reproductive and early-stage characters I have perhaps gone somewhat farther in my consideration of the external adult characters in the "Taxonomy of the Muscoidean Flies,"[4] but so far as I yet know without any great improvement in the general results It is thus evident that, for the future, the older order of taxonomic work in these groups must be exchanged for the newer one, which has come into full light but recently, and which demands the exhaustive study not only of the external and largely the internal characters of the adult, but also of the characters of the eggs and early stages. It may even greatly profit by a study of general bionomics, especially host relations

[4] "Smiths Misc Colls," No. 1803, May, 1908.

It is truly a most remarkable state of affairs that finds us at the present day unable to define some of the most common genera of tachinid flies Nevertheless, such is the fact and necessarily follows from what has here been said The type species of each genus must be dissected before we may know what species, themselves dissected, can be referred to that genus The material for such dissections should be fresh, and that for type dissections should be obtained from the type localities so far as possible I have already done this work for a considerable number of genera, and the results will, I hope, be published within the year accompanied by necessary drawings But hundreds of genera, many of them represented by names long in common use, remain to be investigated in this manner, and thus we frequently find ourselves at this late day unable to determine material in these groups with any hope of finality

In a recent letter to me, Dr John B Smith has restated the conditions in the following apt words, which I can not refrain from quoting:

> It is perhaps not surprising that in the Diptera, which are without any doubt physiologically the most highly developed of all orders, the difficulties in classification should be greatest Their specialization has extended in so many directions that the divergencies have become marked by internal modifications rather than external adaptations

He precedes these remarks by stating his belief "that it will require a study of the internal organs to get a satisfactory classification, which may afterwards be helped out by external characters whose importance is not recognized at the present time" This remark is well worthy of consideration. The correlation of the external adult characters with those of the reproductive system and early stages will define the relative taxonomic value of the first in the various groups, and may reveal unsuspected characters among them which will hold good for considerable series of groups.

The publication at this time of these remarks in their present form has been prompted by the recent appearance of Mr. W. R. Thompson's "Synonymical and other Notes on Diptera,"[4] which have just reached me and which I am extremely glad in this case to see published, since they are here serving the useful purpose of calling forth some timely observations that would otherwise have been reserved for the future. It is hardly possible that the synonymy indicated in the above-mentioned notes will eventually prove to be final. If so it will indicate the possession on the part of its author of most astute perception and perfect judgment of external adult characters, such as I myself can not lay claim to after more than twenty years' study of these flies. For the present, it certainly can not be accepted as such. No matter how carefully done or how clear one's perception, final synonymy in these groups can not be attained by the mere comparison of external anatomical parts in museum material, types or otherwise. It will henceforth be simply a waste of time, energy, paper and ink to put forth such results without correlation with the other characters mentioned, and I will therefore not discuss here the merits of the points raised in these notes, of most of which I have very serious doubt. But I shall return to these points as soon as I can secure proper material for the necessary dissections.

If students wish to further the interests and advance the status of muscoid taxonomy, let them collect, rear and dissect long series of specimens from the type localities concerned; they will then be in a position to deduce final synonymical conclusions. Any other course in the present stage of progress of the work will only further obscure the subject. The same ground will all have to be covered again and all raised or unraised points thoroughly probed to the bottom. In the study of these flies, no matter who agrees as to synonymy, whether generic or specific, if they have not done their work exhaustively their agreement is of slight interest to the matter in hand.

[4] *Psyche*, October, 1910.

The statement that I am going to make now will probably astonish some people, but I can truthfully say that I would be greatly pleased to see half the generic and specific names that have been proposed in the Muscoidea safely relegated to the synonymy where they could rest undisturbed and buried forever, with no hope of a resurrection, a goodly sprinkling of my own among the number, but such a considerable reduction of names is hardly possible of realization. Looking toward a consummation of final synonymy, however, I shall hope to accomplish in the next few years some portion of the work necessary to this end, during the course of which I here pledge my word that those generic and specific names of my own making will receive the same impartial treatment at my hands as all others. My one wish in this matter is to secure certainty before putting a name into the synonymy. The making of incorrect synonymy is a much more serious taxonomic offense than proposing further names for forms already named. In the latter case the forms can always be definitely referred to by means of the names that have been bestowed upon them, but in the former case serious confusion is certain to ensue.

The main interest here, as elsewhere in biology, centers in the relationships, phylogeny, bionomics and kindred aspects of the forms, and this knowledge must point the way to a sound taxonomy. In many groups of organisms this knowledge largely follows a fairly stable system of classification, but here it must precede it. It only remains to impress repeatedly upon the student the extreme difficulty at best of rightly interpreting the characters in such a multitude of forms, many of which are closely similar in the adult; the at least present impossibility in many cases of separating these forms on external adult characters alone; and therefore the absolute necessity for making an exhaustive study with reference to all taxonomically utilitarian characters, external and internal, of all stages.

Let no one think that I have over-estimated the needs of this subject in the foregoing remarks. I further wish to say, in conclusion,

that without doubt all biologists, myself included, will take great pleasure and satisfaction in welcoming to this field all careful workers, whose services should be much appreciated where there is such a vast amount of labor waiting to be performed

CHARLES H T TOWNSEND

PIURA, PERÚ,
January 29, 1911

SPECIAL ARTICLES

METAMORPHOSIS WITHOUT PARASITISM IN THE UNIONIDÆ

IT has been known for a long time that in the genus *Strophitus* Rafinesque the embryos and glochidia are embedded in short cylindrical cords which are composed of a semi-translucent gelatinous substance, and that these cords, which are closely packed together, like chalk crayons in a box, lie transversely in the water-tubes of the marsupium The blunt ends of the cords are seen through the thin lamella of the outer gill, which in this genus, as in *Anodonta* and others, constitutes the marsupium The position of the masses of embryos, while contained within the gill, is so unusual that Simpson in his "Synopsis of the Naiades" established a special group, the Diagenæ, for *Strophitus*—the only genus of the family in which this peculiarity exists In other genera the embryos are conglutinated more or less closely to form flat plates or cylindrical masses, each one of which is contained in a separate water-tube and lies vertically in the marsupium

So far as we are aware, Isaac Lea[1] was the first to observe this interesting arrangement which he described and figured, rather crudely to be sure, in *Strophitus undulatus* (*Anodonta undulata*) In several subsequent communications[2] he added further details and illustrations, and also mentioned the occurrence of the transversely placed cords, or "sacks" as he called them, in *S. edentulus* He recorded the former species as being gravid from September until March, and described the extrusion of the cords from the female, as well as the remarkable emergence of the glochidia from the interior of the cords after the latter have been discharged "The sacks were discharged into the water by the parent," he says, "from day to day, for about a month in the middle of winter Eight or ten young were generally in each sack, but some were so short as only to have room for one or two . Immediately when the sacks came out from between the valves of the parent, most of the young were seen to be attached by the dorsal margin to the outer portion of the sack, as if it were a placenta"

The essential points in these observations have since been verified by other investigators Sterki,[3] following the suggestion of Lea, has called the cords, which differ strikingly from the conglutinated masses of *Unio* and other genera, "placentæ"—thus indicating that he considered them to have a nutritive function He also described the extrusion of the glochidia when placed in water, and their attachment to the cord "by a short byssus thread whose proximal end is attached to the soft parts of the young" He further states that the glochidia are enclosed in the placentæ when the latter are first discharged, and that after their extrusion they remain attached for some time

Ortmann,[4] in a paper on the breeding seasons of the Unionidæ of Pennsylvania, says of *S undulatus,* which he regards as identical with *edentulus*

> I found this species gravid in the months of July, August, September, October, also in May. The latest date is May 22, 1908 (one out of eleven individuals) Among numerous specimens collected on May 14 and May 27, 1908, no gravid females were present, and during the month of June such were never found, although a good number of specimens were collected The earliest date again is July 11 This gives an "interim" from the end of May to about the middle of July

In a later paper Ortmann[5] states that the discharge of the cords, which he proposes to

[1] "Observations on the Genus *Unio*," Vol II, 1838.

[2] *Ibid*, Vols. VI, X, 1858, 1863

[3] *Nautilus*, Vol XII, 1898.

[4] *Ibid*, Vol XXII, 1909

[5] *Ibid*, Vol XXIII, 1910.

call "placentulæ," is not through the lamellæ of the gills, as Simpson has maintained, but that it occurs in the usual manner through the suprabranchial chambers.

Strophitus edentulus is a rare species in all of the localities in which we have collected mussels, and we have obtained, until recently, only the following records of its breeding from individuals taken in the Mississippi River near La Crosse, Wis., during the summer of 1908.

Date	Number of Individuals	Stage of Gravidity
June 10	1	glochidia fully formed
July 6	1	glochidia fully formed
July 9	3	glochidia fully formed
July 10	1	glochidia fully formed
July 9	2	not gravid.
July 17	1	not gravid
July 18	2	not gravid
July 29	1	not gravid
July 29	4	young embryos
August 11	1	young embryos
August 11	3	late embryos

Since these records include the interim between the breeding seasons, they confirm the statement of Ortmann and others that *Strophitus edentulus* is one of the so-called "winter breeders," or those species which have the long period of gravidity. The interval between the seasons, however, as indicated in the above records, is seen to be a much shorter one than that observed by Ortmann.

After verifying the main observations of Lea and Sterki, so far as was possible at that season of the year, we examined the glochidia carefully with a view to determining whether their subsequent life-history would exhibit any peculiarities, as might be suspected from their relation to the cords. At that time we did not observe the normal discharge of the cords by the female; but we removed them from the marsupium, placed them in water, and, after the glochidia had emerged, employed various means to bring about their attachment to fish. None of these attempts, however, was successful, although the fish were left in small dishes containing many cords for as long a time as twelve hours. In the light of these results, which indicated the inability of this glochidium to attach itself to fish, and in view of the fact that the cords so evidently seemed to be a nutritive device, we felt it to be highly probable that in this species the metamorphosis would be found to occur in the absence of parasitism—a prediction which has been recently verified.

On February 6, 1911, a single female of *Strophitus edentulus*, which had been under observation in the laboratory since last November, was seen discharging its cords from the exhalent siphon. The discharge has continued to the present date, March 25, and during this time the cords have been thrown out in varying numbers from day to day. They measure from 2 to 10 mm. in length and about 1 mm. in diameter, although they become more or less swollen after lying in the water for a time. Each cord contains from 10 to 24 glochidia arranged in an irregular row. In many cases the glochidia emerge from the cords in a few minutes after the latter are discharged, and then usually remain attached by the thread in essentially the same manner as has been described by Lea and Sterki. The thread, which is apparently a modified larval thread, is continuous at its distal end with the egg-membrane, which generally remains embedded in the cord, so intimate, in fact, is the union between the two, that at times the membrane, adhering to the thread, is dragged out of the cord when the glochidium is extruded—in which case, of course, the glochidium becomes entirely detached from the cord.

All attempts to infect fish with these fully formed glochidia have again been unsuccessful, even when the exposure has been of long duration. Within a few days, the extruded glochidia die in spite of every effort to provide the most favorable conditions for their maintenance.

When the cords first began to be discharged, one of our students, Miss Daisy Young, happened to notice that not all of the larvæ were extruded, and that among those which remained in the cords some had lost the larval adductor muscle, possessed a protrusible foot, and showed other signs of having undergone the metamorphosis. Upon careful examina-

tion this was found to be true, and it was discovered that these young mussels—for such they undoubtedly are—are subsequently liberated by the disintegration of the cord after *having passed through the metamorphosis in the entire absence of a parasitic period* We, therefore, have concluded that the emergence from the cords in the glochidial stage is premature—due possibly to some change which has taken place in the gelatinous substance surrounding them as a result of free contact with the water or to release from the pressure to which they are subjected while in the marsupium It is perfectly evident that these glochidia neither become attached to fish nor undergo any further development, they have simply come out too soon and are lost

The young mussels, on the other hand, which have developed inside the cords, when liberated by the disintegration of the latter or removed directly by teasing, are found to have reached as advanced a stage of development as is attained by any unionid at the time it leaves the fish They closely resemble the young of *Anodonta* at the close of the parasitic period, and upon examination have been found to possess the following structures the anterior and posterior adductor muscles, the ciliated foot, two gill buds on each side, a completely differentiated digestive tract, including mouth, œsophagus, stomach, intestine and anus, liver, the cerebral, pedal and visceral ganglia, otocysts, the rudiments of the kidneys, heart and pericardium, and also a slight growth of the permanent shell around the margin of the shell of the glochidium. The larval muscle has completely disappeared, although some of the mantle-cells of the glochidium, as well as the hooks of the shell, are still present. They crawl slowly on the bottom of the dish by the characteristic jerking movements of the foot, after the manner of the young of other species at a corresponding stage, although the valves of the shell gape more widely apart and the foot is shorter and less extensible We have not succeeded as yet in keeping them alive for more than ten days, but it is difficult in the case of any species to maintain young mussels of this age under laboratory conditions.

Since these young mussels do not respond to the stimuli which cause glochidia to close the shell and all attempts to bring about their attachment to fish have failed, and, furthermore, since their behavior in creeping on the bottom is characteristic of post-parasitic life, it would seem clear that no subsequent parasitism is possible The conclusion is, therefore, inevitable that we have here to do with a species which has no parasitism in its life-history, although the presence of hooks and other typical glochidial structures would indicate that it has originated from ancestors which possessed the parasitic stage like other fresh-water mussels The cord is undoubtedly to be interpreted as a nutritive adaptation which arises in the marsupium during the early stages of gravidity, since the young embryos are at first contained in an unformed viscid matrix and the cords are a later product

The whole history of this exceptional species warrants a more detailed study, and Miss Young is now engaged in such an investigation When her work is completed, we hope that it may include the entire course of development, the method of formation of the cords, and the rearing of the young mussels during a much longer period than has thus far been possible

GEORGE LEFEVRE,
WINTERTON C CURTIS
UNIVERSITY OF MISSOURI,
March 25, 1911

THE SCALES OF THE ALBULID FISHES

Albula has long been regarded with unusual interest by ichthyologists, being an isolated type standing near the base of the Teleostean series It is exceptional among all teleosteans, Boulenger remarks, in having two transverse series of valves to the bulbus arteriosus instead of one, an approach to the condition of the "Ganoids," in which there are three. Gill admits the "Ganoids" into the teleostean series, and according to his arrangement *Amia* falls in the order Cycloganoidei, just before or below the Malacopterygii, of which *Albula* is a primitive member. In Smithsonian Misc. Coll., Vol 56, No 3, p. 2, I have

described the scales of *Albula*, showing that they have much in common with those of *Amia*, and are very different from those of *Elops*. The Albulidæ are evidently much nearer to the Cycloganoidei than are the Elopidæ, and if these two families stand side by side in the system, it must be understood that they are nevertheless quite far apart in fact. The striking feature of the scales in which *Albula* resembles *Amia* is the entirely longitudinal (instead of transverse) arrangement of the basal circuli, which in fact should be called *fibrillæ*. In *Amia* the nucleus is subapical, and the broad nuclear area is rugulose or covered with fine labyrinthiform markings. All this is seen in the living *Amia calva*, but even more beautifully in the Miocene *Amia scutata* Cope, scales of which I obtained at Florissant last month. Cope states that the scales of *A. scutata* are larger than those of *A. calva*, but I find them to be practically of the same size, with very strong longitudinal fibrillæ, fraying out basally, and a most beautiful and intricate labyrinthiform sculpture in the broad nuclear area. This labyrinthiform condition of the nuclear area is not uncommon among the lower groups of teleosteans in the stricter sense, and is variably developed in *Elops*. In the characinid *Prochilodus rubrotæniatus* Schomb. the transition from the rugose or labyrinthiform nuclear area to the regularly circulate type is curiously shown, the area becoming multinucleate, with several small "islands" surrounded by circuli. *Albula vulpes* has large subquadrate scales, with about three basal radii, leading to deep emarginations of the base, which therein departs markedly from *Amia* and resembles the normal condition of many higher Teleosts. The subapical region is rugulose, very much as in *Amia*, but the true nucleus, just below it, is surrounded by fine regular circuli. It is in this small central region, above the nucleus, that *Albula* has genuinely transverse (concentric) circuli. It is also to be remarked that the basal circuli are all beaded in *Albula*, whereby they differ from *Amia*, but agree with the Osteoglossidæ.

Strong new interest in the Albulidæ has been aroused by the description of a new genus by Mr. Henry W. Fowler in *Proc. Acad. Nat. Sci. Philadelphia*, LXII (1911), p. 651. This very interesting fish, *Dixonina nemoptera*, was found mixed with specimens of *Albula* from Santo Domingo, collected long ago by Gabb. Fowler writes of the scales that they are "cycloid, inner edges mostly crimped, outer or exposed edges thin or membranous and ragged, marked submarginally with a concurrent vertical ridge or striation, the true edge of the scale." I am greatly indebted to Dr. D. S. Jordan for an opportunity to study a couple of scales of *Dixonina nemoptera*, taken from the original type. They are about 8.5 mm. broad and long, and in structure agree perfectly with those of *Albula*. The nucleus with its concentric circuli, the beaded longitudinal basal circuli, the three basal radii and three basal emarginations, etc., are all the same. The dermal pigment spots also agree. In some ways this exact correspondence is rather disappointing, but it shows the conservative nature of the scale-pattern, and rather emphasizes its value as diagnostic not merely of the genus *Albula*, but of the group to which it belongs.

T. D. A. COCKERELL

UNIVERSITY OF COLORADO,
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THE SIGNIFICANCE OF LEAD ARSENATE COMPOSITION

THE control of a large class of the insect pests of growing crops depends on the use of arsenical sprays, and the commercial importance of such spraying has assumed very large proportions in recent years. Two factors determine the limits to which such methods may be carried with success. The first factor is the amount, character and timing of the applications necessary to control the insect. The second factor is the degree of toleration for the spraying treatments which the crop in question may possess. It is with the latter part of the problem that the following discussion is concerned.

Arsenic may injure plants quite as seriously as animal tissue, and the efforts of investigators have been directed towards preventing

the absorption of the arsenical by the sprayed plants It is assumed that solid bodies can not penetrate the epidermis of healthy plants, but the absorption of liquids is known to take place Nothing has developed to show that the first premise is unsound, and the question may well be asked, why have many of the arsenical compounds designated as insoluble by chemists, proved to be injurious when applied as sprays? The most obvious answer is found in the supposition that these compounds are not insoluble under the conditions of the application

Solubility implies a solvent, and the most universally present solvent found in nature is water Chemists base their estimates on solubility in pure water, and on the results of comparatively short exposures to this solvent On the other hand, natural water may not be pure, and under some climatic conditions the exposure of spray deposits, on plants, to the action of natural water may be very prolonged

It is very important to note that the last implied condition, that of prolonged exposure of the spray deposit to moisture, is one which prevails to a great extent in the Pajaro Valley, California This valley is situated near the coast, about one hundred miles south of San Francisco, and opens out onto the ocean The apple orchards of the locality have exhibited a remarkable susceptibility to arsenical injury, and to such an extent as to seriously interfere with effective control of the codling moth by the use of arsenic compounds The industry is a large one, as the production has averaged over three thousand cars annually for the last ten years. An industry of such proportions was deserving of considerable attention from those delegated to foster the horticultural interests of the state, and the university experiment station has properly responded to the demand.

Field and laboratory work was commenced in the spring of 1908, and the author became connected with the investigation in the fall of that year Since that date the work has gone on continuously, and largely under the writer's supervision.

That the results have been satisfactory, is reflected by the methods of spraying and materials used by the growers at the present time The influence of this investigation is also apparent in the orchard practise of the entire Pacific coast and many of the interior states, but comparatively little publication has been done Now that the attention of many investigators is being attracted to arsenical injury and kindred problems it appears that the results of our work should be properly published With this end in view, the author has recently issued a circular entitled "Foliage Testing of Arsenicals" In the present article it is intended to cover in more detail the purely chemical considerations.

To continue with water solubility; the climatic conditions of the Pajaro Valley are peculiar in that there is a large amount of fog and dew moisture through the spring and summer months The foliage of the trees becomes wet early in the evening and remains so during the night and well into the following morning This condition may continue without interruption for a period of several weeks The dew and fog moisture may at times be abundant enough to drip liberally from the trees, but more often it is nearly all retained on the foliage where it evaporates during the following forenoon Such conditions are evidently ideal for dissolving substances on the leaves, and for the absorption of the solutions by the plant tissues As contrasted with rains which wash dissolved substances entirely away, the above-described conditions are much more trying, and partly explain why apple foliage in the eastern states has been so little subject to arsenical injury.

With regard to the action of substances in solution in the water used to suspend arsenical compounds, when applied as a spray, Haywood and McDonnell[1] and others have shown that chlorides, carbonates and sulphates render the arsenic oxide in certain varieties of arsenate of lead more soluble and increase the danger of foliage injury. On the other hand, we have found that distilled water does not

[1] U S Dept. of Agr, Bureau of Chemistry, Bul 131, p 46

eliminate the injury, but may prolong the time required for it to take place. Also, arsenicals of several types, applied as dust sprays (without water), have produced injury under our climatic conditions. At the same time and under the same conditions arsenicals have been applied that produced no injury or a very small amount. Such variation from perfect foliage neutrality to serious injury was found in a series of arsenate of lead samples. The samples which produced no injury were found to still retain their non-injurious properties when mixed up for spraying in any of the various waters in common use in the locality. These waters vary from 40 to 150 parts per 100,000 of salts in solution, chlorides, carbonates and sulphates forming the bulk of the salts.

Thus, all degrees of injury were obtained when samples of that material commonly known as arsenate of lead were applied to foliage with the same water. Such results indicated a radical difference in the chemical properties of the various samples. Chemical authorities mention several plumbic arsenates, but consider them as being alike insoluble in water. However, "Handbuch der Anorganischen Chemie" (O. Dammer), Vol. 11, Part 2, pp. 565 and 566, states that pyro-arsenate ($Pb_2As_2O_7$) is soluble in ammonia while the ortho-arsenate [$Pb_3(AsO_4)_2$] is not. This brief statement requires interpretation and may be expanded as follows:[3] The acid arsenates are stable under acid conditions, but are transposed into the ortho-arsenate, the most stable compound, under neutral and alkalin conditions. This transposition involves the liberation of arsenic oxide or soluble arsenates. The significance is at once apparent. When arsenate of lead is applied as a spray it is subjected to neutral and alkalin conditions. This is especially true if the water used in spraying contains alkalies. That is, the conditions favorable to transposition of the acid arsenates into the ortho-compound obtain. As fast as the neutral waters of fogs, dews and rains wash away the liberated arsenic oxide, or when the latter is absorbed by the plant tissues themselves, the conditions are restored for more to be formed. The ultimate result is the complete transposition of the acid arsenates to the ortho-compound and the liberation of the excess arsenic oxide.

At the time when these conclusions were reached we had the records of a large number of foliage tests with arsenate of lead samples. Checking these off showed that without exception those simple plumbic arsenates which produced no injury contained lead oxide and arsenic oxide in the correct proportions to produce the ortho-arsenate.

These results were obtained in 1906 and in the early part of 1907, and while the evidence was then sufficient to exclude practically all doubt, it was thought best to wait until several years of commercial spraying and supplementary experimental work should give incontestable grounds to announce the deductions as fully supported by experimental evidence.

To continue further with deductions which are probably correct. Some authors recognize pyro-arsenate ($Pb_2As_2O_7$) and others only hydrogen-arsenate ($PbHAsO_4$) as occurring in wet precipitates. Our results apparently show that both compounds may occur in commercial lead arsenate. Foliage tests show that pure hydrogen-arsenate behaves differently from mixtures containing considerable proportions of the ortho-arsenate. These mixtures of ortho and pyro are more rapidly injurious than the pure hydrogen-arsenate.

A chemical explanation of this fact is apparent. Lead-hydrogen-arsenate is $Pb_2As_2O_7$ to which one molecule of water has been added, that is, $Pb_2As_2O_7 + H_2O = (PbHAsO_4)_2$. In other words, $PbHAsO_4$ is a product of the hydrolysis of $Pb_2As_2O_7$. The H_2O may even be regarded as water of crystallization as the hydrogen-arsenate is crystalline rather than amorphous in structure. This rearrangement of the molecule gives opportunity for rapid transposition to the ortho-arsenate, and would

[3] The credit for this interpretation belongs to Mr. E. E. Luther, at that time (1906) an assistant in the laboratory at Watsonville. This discovery not only explained the injurious properties of certain types of lead arsenate, but also indicated the means by which such injury could be overcome.

explain the more rapid injury from samples containing unhydrolized pyro-arsenate.

The Ammonia Test.—The reaction between ammonia water and the acid arsenates of lead may be used to test the presence of these compounds in a sample.

A fair-sized sample (10 to 20 grams) is worked up in water (25 to 50 c.c.) and an equal volume of strong ammonia (26° B.) is added. This is digested with heat, agitated and finally brought to the boiling point. The sample is then allowed to cool and settle, and the clear solution decanted through a filter. The filtrate is boiled until the ammonia is nearly or all driven off. The remaining solution is then made distinctly acid with acetic acid, and a concentrated solution of lead acetate containing free acetic acid is added. Any arsenic acid which the filtrate may carry will then be precipitated in the form of acid arsenate of lead. With no precipitate forming at first, add the lead acetate solution to large excess and allow to stand. A preciptate may appear in a few minutes or an hour.

With this treatment pyro-arsenate, hydrogen-arsenate and mixtures of ortho and pyro give abundant white precipitates. In any case where the precipitate forms at once and can be designated as more than a trace, *i. e.*, renders the filtrate opaque, the sample will prove injurious under foliage test conditions, and will probably prove injurious in commercial spraying operations, especially where climatic conditions favor such injury. On the other hand, samples which show no ammonia test are practically free from foliage-injuring properties.

The ammonia reaction is complete and may be used for the quantitative determination of any arsenic oxide that may be present in excess of that required to form the ortho-compound.

Errors arising from Chemical Tests and Analysis.—It is not enough to know that the ratio of As_2O_5 to PbO is as 1 to 2.90 or more. The essential thing is whether all the PbO is combined with the As_2O_5. Chlorine and organic bodies may retain sufficient lead to materially affect the nature of the compound. In case the arsenic oxide content is slightly greater than it should be, and an estimable quantity of chlorine is present, the sample will certainly give an ammonia test and prove injurious to foliage under test conditions.

The true ortho samples will probably show an excess of lead oxide amounting to 1 to 4 per cent.

The ammonia test is positive except in rare cases where the uncombined lead is sufficient to take up the liberated arsenic oxide.

Water Solubility.—This subject has received much attention from chemists but as usually handled, does not indicate the true condition of the sample. Most arsenicals yield only a limited portion of their arsenic to a given amount of water, but may repeat this a very great number of times. As has already been shown, the liberation of arsenic oxide from the acid arsenates depends on transposition to ortho under neutral and alkalin conditions. However, the amount of arsenic acid taken up by a given volume of water can not exceed a very small quantity before the reaction of the solvent becomes acid and stops the transposition. As a matter of fact, such solutions are neutral or alkalin to litmus.

The water solubility of arsenate of lead is readily shown in a qualitative way by digesting in water for a time (ten to twenty-four hours), decanting through a filter, acidifying the filtrate with acetic acid and then adding lead acetate solution as in the ammonia test. A white precipitate or turbidity indicates water-soluble arsenic oxide. This operation should be repeated a number of times to determine whether the amount of dissolved arsenic oxide remains a constant. With this method of treatment ortho- and acid-arsenate samples show a decided difference in behavior. Both arsenates may show about the same arsenic oxide content per unit volume of water for the first two or three washings. After that, however, the quantity of arsenic removed from the ortho sample will be very much reduced, but that from the acid sample will remain practically constant for a large number of washings. A device by which a con-

stant stream of pure water could be run through the sample and collected for evaporation to a suitable volume would likely be the best method for determining relative water solubility.

Laboratory Preparation of Lead Ortho-arsenate.—Very few American chemists appear to have experimented with the ortho-arsenate of lead. Probably this is due to the fact that the formulas most often published do not produce this compound in the pure state, that is unmixed with acid arsenates. True ortho-arsenate may be prepared as follows.

Solutions of lead acetate or nitrate and arsenic acid or ammonium, sodium or potassium arsenate containing the correct weights of the oxides (1 part of As_2O_5 to 2.90 PbO) are poured together. The water should be sufficient to dilute the precipitate so that it will not form too thick a mass. To this mixture ammonia is added to strong alkalinity. The mixture is digested with gentle heat for an hour or more, allowed to settle, and the clear liquid tested for arsenic oxide as described under the ammonia test. If a precipitate forms, a little more lead solution is added and the procedure repeated until no precipitate appears. It is well to wash the finished product and again treat with ammonia. If any arsenic oxide appears in the filtrate more lead solution should be added. Finally wash to the complete removal of water-soluble salts. In accordance with well-known principles of chemistry the retention of the arsenic oxide will not be complete until there is an excess of the precipitant, that is, lead oxide. For this reason true ortho samples will show less than the theoretical percentage of arsenic oxide (25.59 per cent.). With commercial samples, where allowance has to be made for impurities, this percentage is still further reduced.

It appears, then, that the federal insecticide and fungicide law rules out commercial ortho-arsenate of lead prepared on a 50-per-cent. water basis, by requiring 12.5 per cent. arsenic oxide. The manufacturers may still comply with the law by reducing the water percentage, but this is done at expense of easy remixing, so working a hardship on the consumer. It is my opinion that this clause in the act should be amended to read: "In the case of strictly ortho-arsenate of lead, the arsenic oxide content shall not be less than 11 per cent. or more than 12.5 per cent. on a 50-per-cent. water basis."

Further Discussion of Water.—Haywood, as already cited, has shown that chlorides, carbonates and sulphates may seriously increase arsenical injury from acid and pyro-ortho mixtures even when present in comparatively small amounts. Some recent results with these arsenates in commercial spraying apparently bear out such conclusions. The commercial ortho-arsenate usually contains enough excess lead oxide to offset these effects, but cases can be imagined where this compound might be partly decomposed. In such instances it is clearly possible to overcome the difficulty by treating the water with lead acetate. The addition of lead acetate until the water shows a reaction for soluble lead should give the desired result. The presence of small amounts of lead acetate will not prove injurious, and we have applied the carbonate and sulphate in very large quantities without producing the slightest injury. Lead acetate will completely overcome the effects of carbonates and sulphates and should greatly reduce the solvent action of chlorides.

Acknowledgments.—The investigations of which the features of this discussion form a part have had a wide scope and important contributions have been made by several people, among whom may be mentioned Professors C. W. Woodworth, W. T. Clarke, Geo. E. Colby and Mr. E. E. Luther.

W. H. Volck

Watsonville, Cal.

SOCIETIES AND ACADEMIES

THE WASHINGTON ACADEMY OF SCIENCES

The Washington Academy of Sciences held its 71st meeting in the auditorium of the New National Museum on the evening of April 18, 1911. President F. W. Clarke presided.

Sir John Murray, of Scotland, gave a most interesting and beautifully illustrated lecture on "The Ocean."

Maps were shown that gave the depths of the several oceans, the directions of their currents, their temperatures at all depths, their salinity, density and other physical conditions The importance of each of these phenomena was clearly stated and their interdependence carefully explained It was explained, for instance, that life at considerable depths in the sea is dependent upon vertical circulation, because in this way only is it possible to bring to the lower portions the necessary amount of oxygen This explains the absence of life in the deeper portions of the Black Sea in which the distribution of density is such that it produces horizontal currents only

Even those portions of the ocean farthest removed from land have an abundance of animal life, which in the last analysis must live upon vegetable matter But this, the lecturer explained, is everywhere present in such abundance, though consisting of microscopic individuals, that the oceans may be thought of as vast meadows containing even more vegetable matter than is upon the land

A most interesting and possibly important fact is the change, after a lapse of a few years, in the temperature of the deeper layers of the sargasso sea These temperatures should be taken several times a year for a number of years, for the purpose of determining whether the change is cyclic, and what its causes and its consequences are

These are only some of the topics discussed in a lecture that combined in the highest degree the interesting and the instructive

THE 70th meeting of the Washington Academy of Sciences was held in the assembly room of the Cosmos Club at 8 15 P M, March 30, 1911 President F W Clarke presided

Professor Dr. Victor Goldschmidt, professor of mineralogy in the University of Heidelberg, Germany, presented a paper on "The Nature of Crystals"

The lecturer began with humorous descriptions of school day experiences when we studied crystallography by the aid of painted wooden and pasteboard models, and from them got the idea that real crystals were mighty poor imitations of our beautiful wooden blocks

By way of emphasizing the importance of the subject of crystallography it was stated that all ice and snow, all rocks whether of mountains or in the deep strata of plains, the moon, wandering meteors and all solids from liquids, are crystals

A philosophical and all-comprehensive definition of crystals was then developed, and contrasted with the similar definition of a liquid A crystal was defined as being "A solid system of like particles with like orientation" A liquid was defined as "A system of gliding and rotating particles"

Any one who thinks crystallography either an unworthy or uninteresting subject is very much mistaken, Dr Goldschmidt declared, and by his lecture, in the opinion of all who heard him, made good this claim

W J HUMPHREYS,
Secretary

THE BOTANICAL SOCIETY OF WASHINGTON

THE 73d regular meeting of the society was held at the Cosmos Club, Tuesday, May 2, 1911, at eight o'clock P M President W J Spillman presided Thirty one members were present

Mr Walter T Swingle presented a review of a recent paper by de Vries entitled "Ueber doppeltreziproke Bastarde von *Œnothera biennis* L und *O muricata* L," in *Biologisches Centralblatt*, 31 97-104, No 4, February 15, 1911 This review will appear in full in SCIENCE

The following papers were read

The Recent Excursion into the Dismal Swamp F V COVILLE

After describing an excursion made by the Washington Academy of Sciences into the Dismal Swamp of Virginia, April 28-30, 1911, the author discussed the characteristic plant associations of the Dismal Swamp which are those of the "black gum" and the "juniper" areas, the latter being of unusual ecological interest

The "juniper" lands of the Dismal Swamp have a special flora different from the other floras of the region The characteristic tree is the southern white cedar (*Chamæcyparis thyoides*), locally known as "juniper" The common shrubs are swamp blueberry (*Vaccinium corymbosum*), white alder (*Clethra alnifolia*), inkberry (*Ilex glabra*), fetterbush (*Pieris nitida*), and various other species belonging to the heather family. The soil is a red brown peat, made up of the dead roots, twigs and leaves of the swamp vegetation The water of these juniper swamps contains a remarkably small quantity of mineral matter, and has the color of tea, due to a dilute solution of organic matter derived from the peat When tested with phenolphthalein the water gives an acid reaction, to the degree of .0005 of a normal acid solution The peculiar flora of the juniper swamp

is attributed to the acidity of this water and of the peat from which it flows, the chemical qualities of the water preventing the growth of the organisms of decay, and preserving the soil in such a condition of acidity as to make it impossible for ordinary swamp plants to grow on these lands. The "juniper" trees and other vegetation of these areas are specially resistant to acidity and are able to grow with luxuriance in such a situation. The antiseptic quality of this water is further attested by the estimation in which it has long been held among sailors for drinking purposes. Before the days of distilled sea water, the favorite water supply of ships leaving Norfolk on a long voyage was "juniper" water from the Dismal Swamp. No other water was so highly esteemed and none kept its sweetness so well.

The Effect of the Reaction of Solutions on the Growth of Wheat Seedlings: J. F. BREAZEALE and J. A. LE CLERC. (Read by Dr. Le Clerc.)

The authors showed, by the use of lantern slides of photographs of seedlings grown in various solutions, that the development of the roots of the seedlings was injuriously affected by all the solutions that had become appreciably acid in reaction. This acid reaction was most marked with the application of KCl and K_2SO_4, the plant exerting a selective action for the K ion, thus leaving the acid radicle Cl or SO_4 behind, which in turn made the culture medium acid by which the growth of the roots was stunted. The conclusion was drawn that the reaction of the solution played a most important rôle in the development of the seedlings.

Some Changes which take Place in Stored Grain: DR. J. W. T. DUVEL.

This paper treated mainly of the more important changes which take place in commercial corn during storage in grain elevators and holds of steamships. Corn thus stored frequently contains relatively high percentages of moisture, thus affording an excellent opportunity for the development of molds and bacteria. The development of these organisms, together with the action of unorganized ferments, is accompanied by a distinct and rapid increase in temperature and a marked deterioration in the grain. Such grain is known commercially as "heating" or "hot" and after it starts to go "out of condition" it usually reaches a temperature of from 135° to 150° F. within a very few days. The viability is greatly reduced or entirely destroyed, and there is a marked increase in the acidity, a reduction in the percentage of both sucrose and invert sugar, and a considerable loss in fat. Other important changes also occur in the chemical composition of the grain, together with a heavy loss in weight and a lowering in the weight per bushel.

W. W. STOCKBERGER,
Corresponding Secretary

THE ASSOCIATION OF TEACHERS OF MATHEMATICS IN THE MIDDLE STATES AND MARYLAND

THE sixteenth meeting of the association was held in Teachers College, New York, April 22, 1911. The meeting was called to order by the president, Dr. Wm. H. Metzler, at 10.30 A.M. in the chapel of the college.

After the reading of the minutes, Mr. Breckenridge, chairman of the committee on continuation schools, reported the progress of his committee. The report was very interesting in the matter of the attitude of the students in those schools for more pure mathematics, merely because of their place in the curriculum of the ordinary day school. The report was accepted and the committee was continued. The algebra syllabus committee was also continued.

The first paper of the morning was given by J. S. Rorer, of the Wm. Penn High School, Philadelphia, on "The Curriculum: Present Tendencies, Future Possibilities."

The work of the morning was concluded by a paper by A. M. Curtis, of the Oneonta Normal School, on "Study Supervision: Its Needs in the Mathematics of the Elementary and Secondary Schools."

The first paper of the afternoon was a description, with lecture table models, of the slide rule and its uses, by Clifford B. Upton, of Teachers College. This was followed by a description, with stereopticon illustrations, of the calculating machines then on exhibition in the educational museum of Teachers College.

Preliminary reports for the committees on arithmetic, algebra and geometry were given by Mr. Rorer for the committee on arithmetic and by Mr. Durrell for the committee on geometry. These reports consisted of plans for carrying on the work.

After expressing its thanks to Teachers College the meeting adjourned to the educational museum for the privilege of inspecting the exhibition of slide rules, calculating machines, rare books and manuscripts.

H. F. HART,
Secretary

SCIENCE

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MSS. intended for publication and books, etc., intended for review should be sent to the Editor of SCIENCE, Garrison-on-Hudson, N. Y.

ALEXANDER AGASSIZ: HIS LIFE AND SCIENTIFIC WORK[1]

ALEXANDER AGASSIZ, our distinguished alumnus and my friend, died at sea in mid-ocean on board the S. S. *Adriatic* on Easter morning, March 27, 1910. When this information was received in England by wireless message, it was believed that some mistake had been made, for only a few days previously he had parted with scientific friends in London apparently in most excellent health. The sad news was too speedily confirmed. A few days later I had occasion to speak before an assemblage of scientific men and oceanographers, and I said his death was a great loss to American science, to the science of oceanography, and to all people who take an interest in the progress of natural knowledge. On this occasion I propose to show that this statement was fully justified, and that a truly great man passed from the world when Alexander Agassiz died.

Alexander Agassiz was the only son of the famous naturalist, Louis Agassiz, by his first wife, Cecile Braun, and was born at Neuchâtel in Switzerland on December 17, 1835. His school days were spent at his birthplace and at the Burger School at Freiburg, in Baden, Germany, where his maternal uncle was a professor in the university, where his mother and sisters then resided, and where he also came under the influence of a great biologist, Professor Theo. von Siebold. Here were laid the foundations of an education in the French

[1] Memorial address delivered in Sanders Theater, Cambridge, Mass., March 22, 1911, at the request of the president and fellows of Harvard College. Reprinted from the Bulletin of the Museum of Comparative Zoology at Harvard College.

and German languages and in science, which proved a great advantage in his future career His mother was an artist, and we have hints that her temperament was very different from the placid uniformity which is said to have been characteristic of his father The father and son are said by Dr Walcott, who knew them both well, to have apparently belonged to absolutely different types[2] When I sometimes observed outbursts of indignation, and impatience in Alexander Agassiz, I was always reminded of a passage in the quarrel between Cassius and Brutus in the play of Julius Cæsar

Cassius exclaims

Have you not love enough to bear with me,
When that rash humor which my mother gave me
Makes me forgetful?

And Brutus replies,

Yes, Cassius, and from henceforth,
When you are over-earnest with your Brutus,
He'll think your mother chides, and leave you so

In 1849, at the age of thirteen years, the young Agassiz joined his father in America, and his later education took place at Harvard College and the Lawrence Scientific School at Cambridge, Mass, where the elder Agassiz occupied the chair of natural history. He used to refer with much pleasure and satisfaction to the manner in which he was befriended, soon after his arrival in the country, by Augustus Lowell, the father of our President Lowell In 1855 Alexander Agassiz graduated at Harvard Two years later he took the degree of S B. in civil engineering, and later a second S B degree in natural history Between 1856 and 1859 he taught in the Agassiz School, and here it was he first met, as a pupil, the young lady who was to become his wife In 1859 he was appointed an assistant in the United States Coast Survey, and worked in California and Washington Territory

[2] *Boston Evening Transcript*, April 6, 1910.

In 1860, at the age of twenty-six, he married Anna Russell It was a love match, and the young couple started out with a very slender income. In the same year Agassiz was appointed assistant zoologist in the Museum of Comparative Zoology at Cambridge, founded by his father His connection with this institution lasted as long as he lived—a full half century During half of that period he acted as curator, succeeding his father On resigning the curatorship in September, 1898, he served on the faculty of the museum as secretary In 1902 he was made director of the University Museum

In 1863 Agassiz became interested in coal mining in Pennsylvania, but afterwards turned his attention to the copper mines of Lake Superior, acting as superintendent of the Calumet and Hecla mines from March, 1867, to October, 1868 It was in consequence of his ability, attention, devotion and business habits that these mines turned out a great financial success at a later date Up to the time of his death he was president of this successful company

In 1869 he had a severe illness at Cambridge from the effects of over-work, anxiety and exposure at Calumet, from which it is believed he never fully recovered. The years immediately preceding this illness had been full of all the financial and other worries connected with mine superintendence and the care of a large and growing business. Still even at this busy period we find the dominant note of Alexander Agassiz's life continuously sounded—the desire to add to the sum of natural knowledge

As a boy he had accompanied his father on his cruise in the *Bibb* off Nantucket, and in 1851 he aided in the survey of the Florida Reefs. Before he had reached the age of thirty over twenty publications had

appeared from his pen in various American scientific journals, the subjects ranging from the flight of lepidoptera and beaver dams to the position of sandstones on the shores of Lake Superior, and zoological classification.

The great majority, however, of these papers deal with marine organisms, such as medusæ, salpæ, annelids, actinæ, echinoderms and various pelagic larvæ. These papers, as well as the fact that he published in 1865, conjointly with his stepmother, Mrs. E. C. Agassiz, a popular book on marine life entitled "Seaside Studies in Natural History," show that even in his early career he was fascinated by the ocean, its myriad inhabitants and their conditions of existence. It could not well be otherwise, considering the intellectual atmosphere by which he was surrounded. He took a keen interest in the explorations of his friend, Pourtalès, off the coasts of Florida, and assisted in the description of his collections. In fact Agassiz's early manhood coincided with the great renewal of interest in the physical and biological conditions of the great ocean basins. Maury and Brooke had taught men how to sound correctly the deep sea, and Maury had published his "Physical Geography of the Sea" and a depth chart of the whole North Atlantic. Bailey had examined microscopically the deep-sea deposits under the gulf stream; Pourtalès had discussed the formation of green-sand in the same deposits, and the older Agassiz had pointed out the bearing of these new facts on the question of the permanence of continents and ocean basins. The observations of Lovén and Michael Sars had shown that, if there was a zero of life in the great oceans, it must lie at a much greater depth than Forbes had indicated from his observations in the Mediterranean. Wallich, Huxley and Haeckel had expounded their views on the habitat of the Globigerinæ, the shells of which covered the floor of the ocean, and of some organisms brought up from a great depth on sounding lines. The renowned "Bathybius" had been described as a living carpet on the ocean-floor and was accepted by the scientific world. Wyville Thomson, Jeffreys and Carpenter had conducted deep-sea explorations in the *Lightning*, *Porcupine* and *Shearwater*, capturing in great depths crinoids, irregular sea urchins and other marine creatures which were reminiscent of fossil forms.

All these fresh and striking facts, and the speculations connected therewith, must have been present in the mind of the young naturalist when recovering from his severe illness in 1869. One can well imagine how earnestly he desired to take an active part in the new explorations and investigations which were either then being carried out or were projected for the near future. At this time an unexpected occurrence enabled him to realize a long wished-for opportunity of visiting and examining the echini collections in European museums and of becoming personally acquainted with the British naturalists then engaged in oceanographical work and deep-sea exploration. One day when recovering from his illness he chanced to meet his friend, Mr. James Lawrence, of Boston. Lawrence remarked, "How ill you are looking!" and Agassiz replied that he thought he was dying. "Nonsense," said Lawrence, "what you need is rest and change of scene." "I can not afford it," was the reply. "Oh yes! you can," said Lawrence, "I'll be your banker." Agassiz never referred to this incident without emotion. He always felt that he owed his life to Mr. Lawrence.

Mr. and Mrs. Agassiz sailed for Europe in the autumn of 1869, with their children

and were absent from Boston for fully a year. This was a period of convalescence and of great pleasure and enjoyment; it was also a period of great activity and hard work. His first visit was to Wyville Thomson, who was then professor at Belfast, in Ireland. Years previously they had been in correspondence about the distribution and development of echinoderms, and Agassiz was, of course, anxious to see him and to learn all about the *Lightning* and *Porcupine* expeditions, in which Wyville Thomson had taken part, and concerning which he had just published a statement of results. The subsequent correspondence shows that this, as well as another visit towards the end of 1870, gave the greatest satisfaction to both naturalists as well as to their wives. Agassiz then proceeded to visit and examine the echini collections in nearly every museum in Europe. The great majority of the original type specimens described by the principal writers on the subject during the nineteeth century thus passed through his hands and were critically compared with specimens from the Museum of Comparative Zoology in Cambridge and from the recent deep-sea expeditions. A few extracts from his own letters will best indicate his progress, occupations and impressions during this visit to Europe.

Wyville Thomson had written to Agassiz after his visit to Belfast that he had lost or mislaid some deep-sea specimen, and Agassiz, jocularly, replied from London, assuring him that he had "taken nothing away from Ireland except a bad cold."

From Copenhagen he writes to Wyville Thomson: "What a pleasant place this is! My wife wishes me to send her kindest regards to Mrs. Thomson and yourself. I am here after a most successful trip through Germany, and am on my way to Stockholm. By the time I get through, we shall have been in every place where there is anything to be seen in the way of type echinoderms. I am getting on famously as far as the material for the echini catalogue is concerned. In Berlin I saw many nice things from Japan. I am just finishing the echinoids here with Lutken, who is a most charming fellow. . . ."

From Switzerland (Leuk, August 8, 1870) he writes: "I have done now with my examination of the Echini collections, having now seen them all, and I hope I shall not be prevented from getting out my catalogue very rapidly after my return home."

From Lausanne (August 23, 1870) he again writes to Wyville Thomson: "We have just come back from a charming trip to the mountains, had pleasant weather the whole time, besides doing us all a great deal of good. I am happy to say I am now picking up fast, and if I keep up at the present rate trust to be perfectly well this fall when I go home. We hope to be in London last part of October. We sail 8th November, and I shall manage if possible to take a run to Belfast and see what you have got (that is from the *Porcupine* expedition). . . . I hope you will have the best of luck on your new trip, and find something more astounding than Rhizocrinus, Pourtalèsia or Calveria. Mrs. Agassiz wishes me to thank you very much for your kind invitation, and to send her kindest remembrances to yourself and Mrs. Thomson."

Here are some extracts from his letters immediately after his arrival at home:

"We had a capital passage, except two days when it was rough, it was quite pleasant, the whole not lasting more than a little over eight days from Queenstown, which for the season was admirable. I found father much better than I had hoped

to see him again. He manages to come to the museum for an hour or so a day, sees a few of his friends every day, and keeps going just enough to be employed He improves daily, and I see no reason why he should not have a long period of usefulness yet, though of course nothing like his old work can now be expected from him again "

In March, 1871, he writes (from Cambridge)—"I am just getting out a new edition of the Seaside Studies, which will, however, be a mere reprint"—and in March, 1872 "I hope you will accept the offer to go round the globe, and if you go may you get all the antediluvial things left I am greatly afraid father's expedition is not going to result as well as we hoped, the vessel is a great disappointment, five weeks out of ten they have spent repairing They have left Rio, and the next mail trust to hear from them in the Straits of Magellan "

In April, 1872, he says "Don't be alarmed by the number of my epistles But I wanted to acknowledge at once the safe arrival of the 'Calveria' and of the 'Phormosoma' I need not tell you how greatly obliged I am to you . "

The "Revision of the Echini"[8] began to appear the year after his return from Europe This is the best known of the works of Alexander Agassiz and at once stamped the writer as the leading authority on the subject Part I. deals with the literature, nomenclature, synonymy and geographical distribution of the echini, and extends to 242 pages. Part II. deals with the echini of the east coast of the United States, including a report on the deep-sea echini collected in the Straits of Florida by Pourtalès in 1867–1869, and extends to 136 pages Part III contains the descriptions of the species of recent echini, and extends to 251 pages Part IV deals with the structure and embryology of the echini, and extends to 141 pages The text thus occupies 770 quarto pages, and is illustrated by seven maps showing the geographical distribution and 87 plates giving full figures and details, in addition to numerous wood-cuts in the text This report represents an immense amount of work and close study, and it became the standard for all subsequent investigations dealing with this class of animals

Agassiz throughout his active scientific life was a constant student of echinoderms He worked on starfishes and crinoids, but the principal object of his interest was the recent echini His first publication on this fascinating group of animals was in 1863, and his last in 1909, covering a term of forty-six years, a long period of sustained interest and work. He described a considerable part of the deep-sea species and genera known to science in his monographs on the deep-sea echini collected by the *Challenger*, *Blake* and *Albatross* expeditions He described as new, about one third of the known recent echini, of which there are some 450 species

In addition to systematic work, he published on the development and morphology of echini as well as on their geographical and bathymetrical distribution His work was almost wholly on recent forms, but in several of his works, especially the revision, and *Challenger* report, there is discussion of, and some observations on, fossil echini.

The three years immediately succeeding his return from Europe in December,

[8] "Revision of the Echini," Illustr Cat. Mus Comp. Zool. (Cambridge, Mass), No VII, 1872–1874, by Alexander Agassiz. It was divided into four parts for purposes of publication; Parts I. and II. were issued together in 1872, the introduction being dated August, 1872, Part III. in September, 1873, and Part IV. in January, 1874.

1870, were the most active, fruitful and enjoyable of his whole life. His financial position had greatly improved and his mind was crowded with new schemes and new ideas with reference to the study of the ocean. He visited the *Challenger* expedition when the ship reached Halifax in May, 1873. He was enthusiastic about our captures, and he could teach us much we did not know, especially about echinoderm and annelid larvæ. I remember he showed us how he had proved that *Tornaria* was the larva of *Balanoglossus*. All the younger men of the expedition were pronounced evolutionists or Darwinists, and the name of Agassiz conjured up opposition to such views, but the impression made by Alexander Agassiz was excellent in every direction, the general judgment being that the younger Agassiz was a very different man from his distinguished father. It was freely prophesied that he would have a very brilliant scientific future. He was buoyant, cheerful, confident and possessed a fund of dry humor. He was rather above medium height, with brown eyes and dark complexion. He had a fine presence, dignified bearing and gracious manners. The following note received on board the *Challenger* some months after his visits indicates conscious capacity and the overflowing joy of life: "We are all flourishing here after a very successful summer at Penikese, about which you must have seen plenty in the papers. The museum is getting fuller than an egg, and I don't know what we shall do for room. We have just secured the collection of Wachsmuth—the finest collection of *crinoids* there is from the west, and with what we have, our collection is now superb. I shall attack them soon I hope." (Cambridge, October 24, 1873.)

The scene, the outlook on life, was suddenly changed. His father, Louis Agassiz, died on December 14, 1873. His beloved wife, Anna Russell, who had tenderly nursed and watched at the bed-side of her father-in-law during his last illness, caught cold from exposure on the night of his death, and died from pneumonia within ten days thereafter.

This was a terrible blow to Alexander Agassiz. The light and brightness of his life had suddenly been extinguished. A cloud fell upon him which nothing on this earth could completely clear away. His mental attitude towards the future is plainly stated in a letter written from Peru in March, 1875, and received on board the *Challenger* when we were voyaging in the Pacific. It evoked the deep sympathy of the *Challenger* naturalists. He says:

> I hear of your whereabouts through the papers occasionally, though lately I have not seen anything concerning your movements, as I have been wandering about in Chili and Peru, out of the way of all newspapers. I could not stand the associations of my house after the terrible ordeal I had to pass through, and for about five months I have been listlessly running from place to place trying to wake up an interest in outside matters. It is all well enough as long as I am on the move, and there is the excitement of constantly seeing new things and new people, but when I am settled down for any length of time, and attempt to do any continuous work, it is impossible for me to throw off my troubles, and life seems unendurable. Yet I can not deny that I have had a great deal of pleasure on my trip to South America, and under ordinary circumstances it would have been to me a great store of future enjoyment. As it is I look upon it as so much time passed, and really dread the moment when I shall reach home, or rather my house, for no place can henceforth be a home to me.

Even here, however, what I have called the dominant note of his life—the desire to get new knowledge—rings out strongly, for the rest of this distressful letter is taken up with a detailed description of his

exploration of Lake Titicaca. He had taken his museum assistant with him to help in making collections for the museum at Cambridge, he had chartered the only available vessel, had taken water and air temperatures, had dredged and tow-netted and constructed a bathymetrical chart of this elevated lake, 12,500 feet above sea level—altogether a most interesting description from all points of view.

The Alexander Agassiz before the death of his wife in 1873 was, in my opinion, a very different man from the Alexander Agassiz after that sad event. The first Alexander Agassiz I had seen, but I knew him only very slightly. I have pictured him as he appears to me from his correspondence, from what I have heard from his intimates, and from his own lips. The second Alexander Agassiz I knew well, long and intimately, he was during the last thirty-four years one of my most intimate and valued scientific friends.

During his visit to the *Challenger* at Halifax he promised to come to England on the return of the expedition to see our deep-sea treasures. When he arrived in Edinburgh I referred to the death of his wife, but he held up his hands and said, "I can not bear it." His expression was such that the subject was never again mentioned, although he frequently spoke about his boys. He spent fully two months in Edinburgh, but would not at that time attend any social functions. Every day from early morning till as long as day-light lasted he assisted me in opening boxes and bottles and in separating out the various groups of marine organisms, especially selecting the echini, which he was to take to America, having consented to describe this group of organisms for the report on the scientific results of the expedition. While this work was going on we had abundant opportunity for discussing the work and results of the expedition and every aspect of the new science of the sea. I was relatively young, and often recounted to him the comic and other incidents of the voyage, and he would smile and seem amused. His attitude was, however, in striking contrast to the boisterous merriment of Haeckel when engaged with me in the same place and in similar occupations. On the conclusion of his visit he wrote to Wyville Thomson on January 23, 1877:

> I can't tell you what a pleasant time I have had in Edinburgh, thanks to you and Lady Thomson. It is really the first time since the death of father and my wife that I have felt in the least as if there were anything to live for, and I hope you have put me on the track to get into harness again and do my share of the work I have to do, if not with pleasure, at least cheerfully.

During the last thirty-five years of his life Alexander Agassiz's activities and interests were many and varied. The control and direction of the Calumet and Hecla mines demanded frequent visits to the west, and there we find him conducting valuable experiments in the distribution of underground temperatures in the great depths of the mine. We also find him producing carbonic acid gas to put out a disastrous fire in the mines—said to be the first time this method was thus employed on a large scale.

The first American attempt to found a zoological station at Penikese having failed, he established a zoological laboratory at Newport to take its place, equipping it with all the necessary appliances and accommodations for twelve students. This institution was carried on for twenty-five years—till it was no longer necessary owing to the establishment of the Woods Hole Marine Biological Station.

The important series of oceanographical or deep-sea investigations with which his name is so closely associated have won for

him the gratitude of all subsequent generations of scientific workers He directed three expeditions in the Atlantic in the U S. S *Blake*, and three in the Pacific in the U S. S *Albatross* These dealt especially with the deep-sea, and yielded an immense number of new organisms and new observations concerning the physical, chemical biological and geological conditions of the great ocean basins Agassiz, being a practical engineer, was able to suggest many improvements in deep-sea instruments and methods, the wire rope for dredging and a modified trawl for deep-sea work were among these improvements The general account of the Atlantic expeditions is published in two volumes entitled "Three Cruises of the *Blake*," and the general accounts of the Pacific expeditions are to be found in the bulletins and memoirs of the Museum of Comparative Zoology It would be difficult to overestimate the value of the zoological and other collections amassed during these most excellent and extensive explorations

If we can say that we now know the physical and biological conditions of the great ocean basins in their broad general outlines—and I believe we can do so—the present state of our knowledge is due to the combined work and observations of a great many men belonging to many nationalities, but most probably more to the work and inspiration of Alexander Agassiz than to any other single man Agassiz's researches in the Atlantic resulted in very definite knowledge concerning the submarine topography of the West Indian region and of the animals inhabiting these seas at all depths—probably we know more of this submarine area than of any other area of equal extent in the world because of his explorations. He arrived at the general result that the deep-sea animals of the Gulf of Panama were more closely allied to those in the deep waters of the Caribbean Sea than the Caribbean forms were to those of the deep Atlantic. Hence he concluded that the Caribbean Sea was at one time a bay of the Pacific Ocean, and that since Cretaceous times it had been cut off from the Pacific by the uprise of the Isthmus of Panama

When the *Challenger* expedition carried her explorations down through the central southern Pacific, she found a rather puzzling state of things. In deep water relatively very few animals were captured on the bottom of the ocean when compared with those taken in the great southern ocean or nearer continental shores, those obtained were, however, of rather pronounced archaic types The deposits in the same area were of surpassing interest, large quantities of a deep-brown clay were hauled up, in which were imbedded enormous numbers of manganese nodules and concretions, some of them being formed around sharks' teeth, ear bones and other bones of whales, and others around volcanic fragments mostly converted into palagonite Sometimes hundreds of sharks' teeth and dozens of whales' ear bones were captured in a single haul, and most of them belonged to extinct species. Small zeolitic crystals and crystal balls were also mixed up in these red-brown clays, evidently formed *in situ* More extraordinary still were the minute spherules having a hard black coating and an interior of pure iron and nickel, as well as other minute spherules, called chondres, found hitherto only in meteorites These spherules are believed to have an extra-terrestrial origin, and to have formed at one time the tails of meteorites or falling stars. This was a strange assemblage of things, and some scientific men argued that such a condition of matters must be regarded as local and accidental.

Now Alexander Agassiz explored anew this region of the earth's surface the furthest removed from the shores of continental land, and he found that the same condition of things extended over vast areas of the Pacific Ocean. Here we have almost certainly the region of minimum accumulation on the sea-floor, and recent investigations indicate that there is in these deep deposits more radio-active matter than anywhere else in the solid crust of our planet. A satisfactory and clear understanding of the phenomena has not yet been obtained, but Agassiz's researches take us a long way on the road to a solution of some exceedingly interesting and important oceanic problems.

During the last thirty years of his life, Agassiz became very greatly interested in all coral-reef problems, and organized very many extended expeditions, almost entirely at his own expense, with the view of studying coral reefs, coral islands, and upraised coral formations. It would be wearisome to give even an abstract of all the publications by himself and his assistants dealing more or less directly with these subjects. It can truly be said that he visited, explored and described with much detail every important coral-reef region of the world, in the Atlantic, Pacific and Indian oceans.

Agassiz's special interest in the coral-island problem was apparently first awakened during his visit to Edinburgh in 1876. I had sketched out a series of papers to be presented to the Royal Society of Edinburgh during that session, and he heard the first of these read, viz., "The Distribution of Volcanic Débris over the Floor of the Ocean, its Character, Source and some of the Products of its Disintegration and Decomposition." He became rather enthusiastic about the results arrived at in the paper. Another of these papers dealt with the distribution of carbonate of lime over the floor of the ocean and with coral-reef formations. One of the most striking results of the *Challenger* expedition was the discovery of enormous numbers of pelagic calcareous algæ, pelagic foraminifera and pelagic mollusca in the surface and sub-surface waters everywhere within tropical and subtropical regions, but the dead calcareous shells of these pelagic organisms were not distributed with similar uniformity over the floor of the ocean. In some places they formed pteropod and globigerina oozes, but in the very greatest depths not a trace of these shells could be found in the red clays which covered the bed of the ocean. It was observed that the thinner and more delicate shells disappeared first from the marine deposits with increasing depth, and only the thicker and more compact shells or their fragments reached the greater depths. These conclusions were verified again and again during the cruise of the *Challenger*, and subsequently by Agassiz in his expeditions. Evidently the calcareous shells were removed by the solvent action of sea-water as they fell towards, or shortly after they reached, the bottom of the ocean. In the shallower depths the majority of the shells reached the bottom before being completely dissolved, and there accumulated. The solvent action was also retarded in these lesser depths through the sea-water in direct contact with the deposit becoming saturated, and therefore unable to take up more lime. The explanations thus given to account for the disappearance of carbonate of lime from deep-sea deposits were then applied to the interpretation of the phenomena of coral atolls and barrier-reefs. It was argued that all the characteristic features of atolls and barrier-reefs could be explained by a reference to the biological, mechanical

and chemical processes everywhere going on in the ocean without calling in the extensive subsidences demanded by the theories of Darwin and Dana.

Agassiz almost at once adopted these views, saying, "I never really accepted the theories of Darwin and Dana; it was all too mighty simple. Besides," he added, "this new view is founded on observation and can be verified, and I'll attempt to do it, and will visit coral-reef regions for the purpose."

Darwin, it will be remembered, stated that his whole theory was thought out on the west coast of South America before he had seen a true coral reef.[4] The method of Agassiz was to see every true coral-reef region of the world before he formed any theory.

Darwin's theory of coral reefs may be briefly stated as follows: The corals commence by forming fringing reefs along a shore. The shore commences to subside, but the corals grow directly upwards. In course of time a lagoon-channel is formed between the growing reef and the subsiding shore-line. When this process continues for a sufficient length of time the central island completely disappears beneath the waves, and the lagoon of an atoll occupies ultimately the place of the island. The fringing reef thus develops into the barrier reef, and the barrier reef develops into the atoll.

Agassiz writes in 1909 that the result of his studies on coral reefs has been "to dissent *in toto* from the views of Dana and Darwin regarding the mode of formation of barrier reefs and atolls."

In 1902, after his visit to the Maldives, he wrote to me as follows:

> This will be the end of a most successful expedition, perhaps to me the most interesting visit to a coral reef group I have made. For certainly I have learned more at the Maldives about atolls than in all my past experience in the Pacific and elsewhere. I should never have forgiven myself had I not seen the Maldives with my own eyes and formed my own opinion of what they mean.—Such a lot of twaddle—it's all wrong what Darwin has said, and the charts ought to have shown him that he was talking nonsense. . . . At any rate I am glad that I always stuck to writing what I saw in each group and explained what I saw as best I could, without trying all the time to have an all embracing theory. Now, however, I am ready to have my say on coral reefs and to write a connected account of coral reefs based upon what I have seen. It will be a pleasure to me to write such a book and illustrate it properly by charts and photographs. But it will be quite a job with my other work on hand. I hope to live to 100! or rather I don't hope, but ought to! to finish all.

Later, in 1907, he writes: "I have started on my coral-reef book, but it is a job, a good deal more than I expected. If I stay at home I ought to make good progress." Later in the same year he says: "I fancy I shall have all the time I want to write out my popular account of coral reefs. I have made a fair beginning, and hope to keep the material within reasonable bounds and not allow it to run away with me." Four months before his death he wrote: "I have worked hard at my coral-reef book," and only a few days before his death he told me in London that he had really sketched out this book three times, but found it very difficult indeed to deal satisfactorily with the mass of information that had been collected. It was his intention, he stated, to write this book during the present year practically for the fourth and last time, leaving out all criticism of the work of others and stating exactly what he had himself observed and his own views.

When in 1903 he addressed the Royal Society of London on coral reefs, he simply described what he had seen in the various

[4] See "Life and Letters of Charles Darwin," Vol. I., p. 70, London, 1887.

coral-reef regions, and did not enter into any controversial matters. The real point of his address came out in the subsequent discussion, viz., that in all his investigations and voyages he had not seen one single atoll or barrier-reef which could be said to be an illustration of the Darwinian theory of coral reefs. It was evident to a large number of naturalists who had themselves observed in the field that the subsidence theory was no more necessary to account for the characteristic features of atolls and barrier reefs than the elevation theory of Darwin—published about the same time—was necessary to account for the Parallel Roads of Glen Roy in Scotland.[5]

It is difficult to account for the heated controversies which have raged around the coral-reef question. Possibly these would never have taken place had the subsidence theory not been associated with the name of Darwin. Very many of the public did not seem to realize that this theory of coral reefs was the work of Darwin when young and inexperienced, and had nothing whatever to do with the theory of natural selection. When the late Duke of Argyll published his famous article entitled "A Conspiracy of Silence," in the nineteenth century (September, 1887), he gave *Bathybius* and *coral-reef theories* as illustrations, and many people regarded the article as a suggestion that Darwinists and evolutionists were disposed to burke free discussion. This was hotly resented by Huxley and others, while some naturalists seem to have believed they were called upon to defend Darwin's coral-reef theory, although they had never seen or examined a coral-reef. Agassiz kept severely aloof from all these controversies, although he writes that he was much amused by the style of various articles and controversies. In one letter to me (March, 1888) he writes: "I am glad to see by last *Nature* that you are taking a hand in the coral discussion now that it has reached *hard bottom* and no longer deals with imaginary quantities, impossible algebra and metaphysical squibs."

All scientific men must regret that Agassiz was not spared to publish the long-expected summary of his coral-reef work, and to learn that he has not left behind any manuscript suitable for publication giving a connected statement of his views. Such a work from his pen would doubtless have been a splendid edifice erected on the magnificent foundation of observation laid with so much expense, trouble and care in the elaborate memoirs on the coral-reef regions he had visited in all parts of the world.

Throughout all these coral-reef investigations I have been in substantial agreement with Agassiz's views. In these circumstances I need make no apology for giving a short statement of the conclusions at which, I think, Agassiz had arrived as a result of his coral-reef investigations.

Agassiz claimed, I believe, to have shown that existing atolls and barrier reefs in no way indicate, even approximately, the former position of the shore lines around islands or along coasts now deeply submerged beneath the ocean.

The submerged banks from which atolls and barrier reefs now arise have been formed—that is, they have been built up or leveled down—in a great variety of ways, and at very different times. Each coral-reef region must in this regard be studied by itself, account being taken of

[5] See "Observations on the Parallel Roads of Glen Roy, and of other parts of Lochaber in Scotland, with an attempt to prove that they are of marine origin," *Phil. Trans.*, 1839, p. 39; *Edin. New Phil. Journ.*, Vol. XXVII., p. 395, 1839.

the surrounding physical and geological conditions.

The reefs themselves have been very largely—in some instances, predominantly—made up of lime-secreting organisms other than the so-called reef-building corals, such as calcareous algæ, foraminifera and corals other than true reef builders, many of which have a wide depth range.

The characteristic features of coral-reefs—the central shallow lagoon and the surrounding rim of living coral with deep water outside—are mainly to be explained by biological, chemical and mechanical activities continuously in operation at the present time, there being vigorous growth of all lime-secreting organisms wherever the conditions of life are most favorable, and less vigorous growth and even death of these organisms where the conditions are unfavorable. A detailed study of the favorable and unfavorable conditions for different species in an existing atoll seemed to Agassiz a great desideratum at the present time and I am delighted to learn that this is now being undertaken by American naturalists under the auspices of the Carnegie Institute.

In small atolls, where the surrounding reef is very extensive relatively to the enclosed lagoon, the lagoon tends to become filled up by the accumulation of coral sand, the deposition of carbonate of lime by the living organisms of the atoll being in excess of that removed in solution and by mechanical means, where the atoll is large, and the encircling reef is—relatively to the size of the lagoon—small, then the lime removed from the lagoon by solution and currents is greater than that deposited by living organisms; hence the lagoon becomes deeper and wider. The lagoon of Diego Garcia appeared to have increased considerably in area in this way between 1837 and 1885.

It is undoubtedly true that many coral-reef regions have been recently elevated. The circular atoll and barrier reef can not be accepted as evidence of subsidence, the characteristic features of coral reefs would be very similar in a stationary, in a slowly sinking or slowly rising area, although each would show secondary modifications. It matters not whether the change of sea-level be due to crustal movement, to attraction of elevated continental land, or to the accumulation or the melting of polar ice-masses.

When coral plantations rise from a submerged bank, the corals and other lime-secreting organisms situated towards the seaward edge would from the first have the advantage, they would hence reach the surface, before the central portions, where the corals would be in a position more or less unfavorable for vigorous growth. A shallow lagoon would thus be formed, which might subsequently be cleared by solution, and mechanical action of many of its living coral plantations.

The coral atoll, on reaching the surface would, he admitted, in very many cases advance seawards on a talus of its own débris, expanding like a fairy ring, and it seemed to him more than probable that the boring at Funafuti atoll was driven down into such a talus, with an underlying Tertiary base.

The red earth which is found on coral islands and supplies the food for plant life, is chiefly derived from the disintegration and decomposition of floating pumice, which is frequently thrown up by the waves on the reefs.

These results of Agassiz depend on a far greater number of original observations, in widely scattered areas, than have been made by all the other authorities on coral reefs put together.

When we attempt to survey the life-work of Alexander Agassiz, we are aston-

ished at its amount, variety and quality His activities in any one direction would have been an excellent record for any one man, but he was many sided He was largely engaged in commercial undertakings and directed a great business during the whole latter half of his life, he carried on detailed researches and published splendid memoirs on the group of echinoderms—a subject on which he was regarded as the leading authority In his deep-sea researches he added greatly to the world's knowledge of the great oceans, and inspired the investigations of a very large number of zoological and other specialists In his study of coral-reefs he traveled more extensively than any man of his time—many thousands of miles—with one special object in view—to see with his own eyes the varied forms which these gigantic and beautiful natural structures assume under different conditions We must likewise take into account his work in the laboratory and in the study, where the reports on his many voyages, cruises, travels and collections had to be prepared for publication Again one must recall the services he has rendered to his *alma mater*—Harvard University—in his general assistance in administration, his special care of its museums, his donations for extensions in many directions, and lastly his altogether grand series of publications from the Museum of Comparative Zoology [*] His great desire was to add to the sum of natural knowledge by his own work and by the impulse he could give to others imbued with a similar spirit and desire. He worked and struggled continuously and heroically with that end in view, and with those who are now engaged in working up his results and collections in all civilized countries he is still a living force, and will be so for many years to come, for he has arranged for the publication of all the results of these researches I used to meet him nearly every year either in Europe or in America, when we spent a few days together discussing almost all oceanic problems I am conscious of his effect on my life and all my scientific work As an example of the influence he exerted we have only to look at the introduction to the three splendid volumes recently published on the medusæ of the world by Alfred Goldsborough Mayer, where the initiation and encouragement of a generous master and friend are gracefully acknowledged Many instances might be cited to show how well and judiciously he applied his wealth to set agoing work which he considered worth doing, not only in his own time but also in the future The large number of decorations and honors which were conferred on Alexander Agassiz by governments and universities and by learned societies in all parts of the world show abundantly how highly his scientific labors were appreciated by his contemporaries

It has been truly said that man does not live by bread alone History is crowded with instances illustrating the fact that men have cast off this mortal coil as so much worthless dross when impelled by the demands of some spiritual truth Other men have endured the greatest hardships and privations in their endeavors to create the beautiful in form, in sound or in color. As it has been with the religious and artistic spirit in the past, so is it with the modern scientific spirit The desire to find out the secrets of nature impels men to trudge over Arctic and Antarctic ice-fields with the satisfaction of all bodily requirements reduced to a minimum and burdened with a load of scientific instruments. Other men expose their bodies to the at-

[*] Fifty-two volumes of the *Bulletin* and thirty-two volumes of *Memoirs*.

tacks of pestilential microbes for the advance of knowledge and the betterment of man's estate, while Alexander Agassiz rises with difficulty, when overwhelmed with sickness, and has his mattress laid on the deck of the tossing steamer in order that he may the better record the message which the dredge or trawl has brought to light from the dark abysses of the Atlantic or Pacific Ocean In such men the body has truly become merely the vehicle of the soul.

It has been said that Alexander Agassiz was a sad and reserved man It must be admitted that during the latter part of his life he was not so moved by joyous impulses as in his earlier years Those who knew him well did not find him reserved, and they can testify to the great pleasure he derived from a new discovery or a new view of the interrelations among natural phenomena

It has also been said that he did not interest himself in the deeper philosophical aspects of the researches in which he was engaged This I believe to be a mistake. He professed never to engage in discussions except where it was possible to verify one's conclusions by an appeal to observation or experiment Although he did not publish papers dealing directly with philosophical subjects, still he was keenly interested in all evolutionary problems He used to say that Darwin had probably explained the survival but not the arrival of species, and he looked forward to a great increase of knowledge from experiments in Mendelism He believed that the mutation theory had received remarkable confirmation by experiments carried on in recent years He believed that the doctrines of heredity, which had been so successfully applied to the improvement of domestic plants and animals, would, in the not very distant future, be in like manner applied for the elevation of the human species, the most important of all domestic organisms. He felt convinced that the modern theories as to electrons, the disruption of atoms, and as to energy configurations in the ether being the sole ultimate phenomenal basis of matter would in time profoundly affect the philosophical outlook of many naturalists and their mental attitude generally towards materialism and the riddles of the universe The study of the world of physical and mental phenomena, he would say, was sufficient for this life The deeper and more earnestly these were investigated, the brighter and more definite would become the glimpses of that eternal something lying behind all manifestations, which in the meantime he was content to reverence His religious feelings seemed to be best expressed as a yearning after a higher and better life, which he held would become more attainable and more pronounced as mankind advanced in scientific knowledge Like all great men he was

> A dreamer of the common dreams,
> A fisher in familiar streams
> He chased the transitory gleams
> That all pursue,
> But on his lips the eternal themes
> Again were new

Great he unquestionably was. Great in his power for work, great in his conception of duty, great in his desire to add to natural knowledge, great in the height of his love, great in the depth of his sorrow, great in his elevated personality, great in his admiration for his university, great in his patriotism, great in his ideas as to the destiny of our race, great in his influence for good, like the genial and vivifying rain from heaven. Like all of us he doubtless had faults, both hereditary and acquired We know that

His life was gentle, and the elements
So mix'd in him, that Nature might stand up
And say to all the world, "This was a man!"

When his near relatives and dear friends affectionately laid his mortal remains beside those of his beloved wife last March in the Forest Hills Cemetery, well might they ask—

What hallows ground where heroes sleep?
'Tis not the sculptured piles you heap
But strew his ashes to the wind,
Whose sword or pen has served mankind
And is he dead, whose glorious mind
Lifts mine on high?
To live in hearts we leave behind
Is not to die

JOHN MURRAY

CHARLES M SCAMMON

CAPTAIN CHARLES M SCAMMON, U S R M, retired, senior officer of the service, died at his home, in East Oakland, Cal, May 2, in his eighty-sixth year His death followed in less than twenty-four hours after that of his wife to whom he had been united for sixty-five years

Captain Scammon was a native of Maine and came to the west coast in 1853, and for a time was engaged in the pursuit of whaling He was the discoverer of the large lagoon on the west coast of Lower California in latitude 27° 50′, which has since borne his name In 1861 he joined the revenue service with which he was connected until his death He was detailed by the government to assist in the explorations of the Overland Telegraph Expedition in 1865, and commanded the flagship of their fleet for three years To his intelligent and kindly cooperation the scientific corps of that expedition owed much of their success. Captain Scammon early became interested in the natural history of the marine mammals of the Pacific coast, and in those days before the invention of photographic dry plates, spared no trouble in gathering measurements, drawings and other data bearing on the cetacea. In 1874 these investigations were summed up in his finely illustrated quarto volume on the "Marine Mammals of the Northwestern Coast of North America," which forms the most important contribution to the life history of these animals ever published and will remain a worthy monument to his memory

WM H DALL

SCIENTIFIC NOTES AND NEWS

PROFESSOR E C PICKERING, director of the Harvard College Observatory, has been created knight of the Prussian order Pour le mérite Simon Newcomb and Alexander Agassiz are the only other American men of science on whom this honor has been conferred

DR THEODORE WILLIAM RICHARDS, professor of chemistry at Harvard, who is going to England at the invitation of the Chemical Society to deliver the Faraday lecture, will be given the honorary degree of D Sc by the University of Manchester on July 8

DR FREDERICK W TRUE, who has held the position of head curator of the department of biology in the U S National Museum since 1897, has been appointed assistant secretary of the Smithsonian Institution in charge of the library and exchanges

LORD CURZON, of Kedleston, has been elected president of the Royal Geographical Society in succession to Major Leonard Darwin

THE Hanbury medal of the London Pharmaceutical Society for 1911 has been awarded to M Jean Eugène Léger, chief pharmacist to the Hôpital St Louis, Paris

THE Royal Academy of Sciences of Berlin has elected Dr James George Frazer, fellow of Trinity College, Cambridge, and professor of social anthropology at Liverpool University, a member of the Philosophical-Historical Section

THE American Philosophical Society at its recent meeting, elected the following residents of the United States to membership George A Barton, professor of Semitic languages, Bryn Mawr College, Bertram Borden Boltwood, professor of radio-chemistry, Yale Uni-

versity; Lewis Boss, director of the Dudley Observatory, Albany, N Y, John Mason Clarke, state geologist and paleontologist and director of the State Museum and Science Division of the Educational Department, Albany, N Y, W M L Coplin, professor of pathology and bacteriology, Jefferson Medical College, Philadelphia, John Dewey, professor of philosophy, Columbia University; L O. Howard, chief of the Division of Entomology, U S Department of Agriculture, Joseph P Iddings, Washington, D C, Alba B. Johnson, Baldwin Locomotive Works, Philadelphia, Pa; A A Noyes, professor of physical chemistry, Massachusetts Institute of Technology, G H Parker, professor of zoology, Harvard University, A Lawrence Rotch, director of the Blue Hill Meteorological Observatory and professor of meteorology, Harvard University, Dr Leo S Rowe, Philadelphia, Pa, Dr William T Sedgwick, professor of biology at the Massachusetts Institute of Technology and biologist of the Massachusetts State Board of Health, and Dr Augustus Trowbridge, professor of physics at Princeton University The following foreign residents were elected Dr Svante Arrhenius, director of the Nobel Institute, Stockholm; J B E Bornet, Paris, Sir John Murray, Edinburgh

Professor Ugo Mondella, director of the geophysical observatory at Leghorn, has been appointed director of the Observatorio Regional do Rio Grande do Sul, Porto Alegre, Brazil

The delegates of the University Museum, Oxford, have appointed Dr. H. L. Bowman, fellow of Magdalen College and Waynflete professor of mineralogy, to be their secretary, in place of Mr H Balfour, curator of the Pitt-Rivers Museum, who resigns that office next month.

Mr. J. Clyde Marquis, instructor in agricultural journalism and agricultural editor at the University of Wisconsin, has accepted the position of agricultural editor of the *Country Gentleman*, recently purchased by the Curtis Publishing Company, Philadelphia. Mr. John Y. Beaty, associate editor of *Farm and Home* and the *Orange Judd Farmer*, has been appointed instructor in agricultural journalism and agricultural editor in place of Mr Marquis

The Academy of Natural Sciences of Philadelphia has appointed the following delegates Professor Carlo Emery to the fifty-year jubilee of Professor Giovanni Capellini, Professor G O Sars to the centennial anniversary of the founding of the University of Christiania and Mr Henry G Bryant to the tenth International Geographical Congress

Professor W B Herms, of the University of California, is on his way to Europe where, during the summer, he will visit the principal parasitological laboratories of England, France, Germany and Italy He will represent the University of California as authorized delegate to the International Hygiene Exhibit at Dresden

Mr William Bateson, F R S, has been appointed Herbert Spencer Lecturer at Oxford for 1911

Dr. William T. Sedgwick, professor of biology in the Massachusetts Institute of Technology, will give the commencement address at the Worcester Polytechnic Institute on "Science and the State"

Professor W. J. V. Osterhout addressed the Biological Society of Smith College, May 18, on "Some Aspects of the Action of Mineral Salts on Plants"

Dr G B. D de Nancrede, of the medical department of the University of Michigan, will give the commencement address before the Medical College of the University of Nebraska, at Omaha, May 18 His subject will be "False and True Professional Success."

Professor H. H Turner delivered the Halley Lecture at Oxford on May 22, his subject being "The Movements of the Stars."

Professor B. G. Wilder was born in Boston, not (as stated in our last issue) in Brookline, where his boyhood was passed.

WE learn from *Nature* that the committee of the Robert Koch memorial endowment for the encouragement of research in the subject of tuberculosis has decided to give grants to Professor Schieck and Dr Krusius for investigations on tuberculosis of the eyes, to Dr. Weinberg for statistical inquiries relative to tuberculosis and to Professor Gaffky for the continuation of his researches Since the year 1908 the sum of £3,000 has been expended by the committee in scientific work

A STATUE to the memory of Priestley is to be erected in the market-place of Birstall, the town of his birth

It is proposed to erect a monument to Richard Lander at Forcados on the lower Niger, of which he was the discoverer

DR STANFORD EMERSON CHAILLÉ, for forty-one years professor of physiology and pathological anatomy in the medical department of Tulane University, retiring as professor emeritus in 1908, eminent for his contributions to hygiene and public health, died on May 28 in his eighty-first year

PROFESSOR SOLOMON WOOLF, professor emeritus of drawing and descriptive geometry in the College of the City of New York, died on May 27 He was born in Mobile, Ala, seventy years ago, and was graduated from the College of the City of New York in 1859 He remained there as instructor and professor for the rest of his life, being made professor emeritus in 1901.

PROFESSOR KEINOSUKE OTAKI, professor of ichthyology and fishery matters in the Agricultural College at Sapporo, Japan, died on April 26, 1911, his death being the result of an injury in a railway accident three years before, from which he never recovered He was the first Japanese student to enter Stanford University, from which he graduated in 1894. He devoted himself to research on the fisheries, was for a time an assistant on the United States Fish Commission, and is the author of several valuable papers on the fishes and fisheries of Japan. For some ten years he was professor of English in the Imperial Military Academy in Tokyo He was one of the most active and efficient of the Japanese naturalists.

DR N STORY MASKELYNE, from 1856 to 1895 professor of mineralogy at Oxford, died on May 27, in his eighty-eighth year.

THE fifth International Philosophical Congress will hold its meeting in the buildings of the University of London in the spring of 1915

THE Otho S A Sprague Memorial Institute was organized in January, 1911 It is a memorial to the late Otho S A Sprague, who for many years was a resident of Chicago and who died about two years ago in Pasadena, California Mr Sprague designated his brother, A A Sprague, as the chief instrument through whom funds left by will should be expended The institute was organized by Mr A A Sprague with the following named gentlemen as members of the corporation and the first board of directors Martin A Ryerson, Charles L Hutchison, A C Bartlett, Byron L Smith, Albert A Sprague, 2d, Dr Frank Billings, John P Wilson and Albert A Sprague For the present the directors have decided upon medical research as the chief object for which the income of the memorial funds shall be expended and have selected Dr H Gideon Wells, associate professor of pathology in the University of Chicago and Rush Medical College, to direct research in medical problems The work will be done in cooperation with existing institutions, viz, the University of Chicago, Rush Medical College, the Presbyterian Hospital and the Children's Memorial Hospital of Chicago The institute will command a definite number of beds in the Presbyterian Hospital for the study of any diseases under investigation An advisory council has been appointed consisting of Drs. Frank Billings, James B Herrick, Joseph L. Miller and Professors E. R. Le Count, Ludvig Hektoen, E O. Jordan and Julius Stieglitz.

THE Surgeon-General of the army announces that preliminary examinations for

the appointment of first lieutenants in the Army Medical Corps will be held on July 10, 1911, and September 5, 1911 Full information concerning these examinations can be procured upon application to the "Surgeon-General, U S Army, Washington, D C" The essential requirements to securing an invitation are that the applicant shall be a citizen of the United States, shall be between 22 and 30 years of age, a graduate of a medical school legally authorized to confer the degree of doctor of medicine, shall be of good moral character and habits, and shall have had at least one year's hospital training, after graduation The examinations will be held concurrently throughout the country at points where boards can be convened Due consideration will be given to localities from which applications are received, in order to lessen the traveling expenses of applicants as much as possible The examination in subjects of general education (mathematics, geography, history, general literature and Latin) may be omitted in the case of applicants holding diplomas from reputable literary or scientific colleges, normal schools or high schools, or graduates of medical schools which require an entrance examination satisfactory to the faculty of the Army Medical School In order to perfect all necessary arrangements for the examination, applications must be complete and in possession of the Adjutant General at least three weeks before the date of examination Early attention is therefore enjoined upon all intending applicants There are at present sixty-one vacancies in the Medical Corps of the Army

A BIOLOGICAL party from the University of Nebraska has been formed for the purpose of carrying on ecological work in central and western Nebraska during the coming summer The party will spend all the time between June 15 and September 15 in the field, dividing the period between three selected stations, where sets of recording apparatus will be installed, and from these making excursions to other points The party includes Dr. Robt H. Wolcott and Mr. Frank H. Shoemaker, of the department of zoology, and Professor Raymond J Pool, of the department of botany, from the university, and Professor Cyrus V Williams, professor of botany in Nebraska Wesleyan University In addition to those named, who will devote the whole summer to the work, other persons specializing in certain lines will be with the party for shorter periods at different times during the summer The particular problems which the party will deal with are concerned with the ecology of the sandhill region of Nebraska and the biological conditions in the Cherry County lakes

SPEAKING in the House of Commons on the budget proposals, Mr Balfour, as quoted in *Nature*, asked the chancellor of the exchequer to exercise caution in carrying out his scheme for the expenditure of large sums of money on building consumption sanatoria In the public mind, he said, there had perhaps been an exaggerated enthusiasm for this method of dealing with tuberculosis There was an idea that this open-air treatment had produced such marvelous results that through it alone tuberculosis could be, if not exterminated, at all events diminished to such an extent that it might be reduced to one of the rare zymotic diseases. He was not sure that the most recent investigations bore out that view There were very able investigators who took the view, after examining the actual results in England and in Germany, that so many complete cures must not be expected as was at one time hoped for He took a sanguine view as to the treatment of tuberculosis, for he believed that science had made great strides and was still destined to make great strides, but when they came to such large sums as those mentioned by the chancellor of the exchequer, it was possible to waste money on permanent buildings which might be better devoted to scientific investigation into the cause of the disease They must not assume that all that they had to do was to spend money on these sanatoria in order to effect a cure. What was important was that medical science had made great progress, and we re-

quired further investigation and perpetual study as to how these people were to be treated when in the sanatoria One of the greatest benefits, perhaps, of establishing these sanatoria would be in giving expert medical authorities the opportunity of carrying on investigations which would enable them in the future to deal with this disease in a way they were not able to do at present In reply, Mr Lloyd George said he agreed that the important thing was to encourage scientific investigation, so as to arrive at the best methods of cure That was provided for in his bill There would be set aside a special fund for the purposes of scientific research The government would make use of and assist existing sanatoria, those which had been maintained by voluntary contributions, and even those which were built by private enterprise

UNIVERSITY AND EDUCATIONAL NEWS

MR MORTON P PLANT has offered to give an endowment of $1,000,000 for the woman's college which is to be established at New London, Conn It is a condition that the name shall be changed to the Connecticut College for Women

THE General Educational Board has made public a list of its latest appropriations for colleges and schools, amounting in all to $634,000 All the gifts to colleges are conditional and are applied to endowment only Other gifts may be applied to current expenses The list follows

College	Appropriation	To Be Raised
Converse, Spartansburg, S C	$50,000	$100,000
Drury, Springfield, Mo	75,000	325,000
Franklin, Franklin, Ind	75,000	325,000
Franklin and Marshall, Lancaster, Pa	50,000	225,000
Huron, Huron, S D	100,000	100,000
Pennsylvania, Gettysburg, Pa	50,000	150,000
Totals	$400,000	$1,225,000

Appropriations aggregating $68,000 went to the education of southern negroes, $130,000 is set aside for demonstration work in agriculture, also in southern states, under the supervision of Bradford Knapp, and $36,000 for professors of secondary education in state universities of the south

BROWN UNIVERSITY receives a bequest of $85,000 from Oliver Henry Arnold, M D, of Providence

THE Boston Edison Company will give the Massachusetts Institute of Technology $3,000 for a period of years for the purpose of electrical research involving a thorough investigation of the use of electricity in vehicles employed in trucking or delivery

WESLEYAN UNIVERSITY has purchased ground from the Russell estate as a site for a new observatory, which will be erected from the proceeds of a fund given in 1903 by Mr Joseph Van Vleck This gift has been increased by others, and now approaches $60,000

SIR FELIX SEMON, M D, has transferred to the University of London, for the foundation of a lectureship in laryngology, a sum of money amounting to £1,040 presented to him by the British laryngologists on his retirement from practise

THE Connecticut Agricultural College will conduct from July 5 to 28 a summer school of nature study, agriculture and agricultural pedagogy, of which Professor A F Blakeslee is the director

PROFESSOR GEORGE F KAY, who has been for four years professor of petrology and economic geology in the University of Iowa, has been elected head of the department of geology to succeed Dr Samuel Calvin, who died on April 17 Professor Kay has also been chosen by the Geological Board to succeed Professor Calvin as director of the State Geological Survey

DR CHARLES LINCOLN EDWARDS has been appointed assistant professor of biology and assistant director of the marine biological station in the University of Southern California.

LIEUT COL WIRT ROBINSON, Coast Artillery, has been nominated by the president to be professor of chemistry at West Point, to take

effect on October 3, to succeed Col. Samuel E. Tillman, who has been the head of the department of chemistry, mineralogy and geology since December 21, 1880, and retires for age on October 2.

The following changes take place in the department of philosophy in the University of Michigan: Professor Alfred H. Lloyd has leave of absence for the year 1911-12. During his absence Charles Milton Perry, Ph.D. (Mich.), joins the staff as instructor in philosophy. Dr. John F. Shepard, instructor in psychology, has been advanced to an assistant professorship. An additional instructorship in psychology has been created. It will be filled by Henry Foster Adams, Ph.D. (Chicago). Harry Wolven Crane, A.B. (Mich.), at present assistant in psychology, has been elected to the George S. Morris memorial fellowship for the year 1911-12.

The following appointments have been made at McGill University: Dr. N. H. Alcock, to the chair of physiology; Associate Professor Ernest Brown, to be professor of applied mechanics and hydraulics; H. Barton, to be professor of animal husbandry at Macdonald College. The following promotions have been made in the faculty of applied science: Mr. Batho, assistant professor of mechanics; Mr. Graham, assistant professor of mineralogy; G. M. G. Johnston, assistant professor of chemistry; H. M. Lamb, assistant professor of civil engineering; S. W. Werner, lecturer in assaying.

DISCUSSION AND CORRESPONDENCE

ACADEMIC AND INDUSTRIAL EFFICIENCY

There is one way in which the efficiency of industrial concerns and of educational institutions can be compared effectively, viz., in the administration of the finances.

In the following paragraphs, a number of representative educational institutions are compared to the railways of the United States as to the ratio of compensation of labor to operating expenses.

According to "Railway Statistics of the U. S. of America for the year ending June 30, 1909,"[1] the ratio of compensation of labor to operating expenses is 62.06 per cent, which, if we except one year, is the highest ratio in eleven years past.

Moreover, we might state that the usual rule for industries in general is that about 65 per cent of operating expenses goes to labor.

In the case of the railway statistics quoted above the salaries of administrative officers, "clerks" and "all other employees" are included, as shown on page 36, and as expressly stated to the writer of this article by the compiler of the statistics.

Thus in the following statistics on educational institutions, salaries of administrative officers and all other employees, are included along with the "productive" laborers, in this case, the teachers.

And, moreover, we must remember here that while a railway administrative officer is *only* an administrator and in no wise "productive," the administrative officer of the university or college is often, and indeed, in colleges prevalently, also a teacher and thus is "productive."

Moreover, the highest salaried officers in educational institutions are in all cases "productive" whether they do actual class-room teaching or not. Presidents and deans in all colleges and universities are productive, in that they lecture a good deal, and hold numberless consultations with students which are as valuable, or more so, to the latter as are the consultations with the professors.

But the institution which pays the most to "productive" labor is the most efficient.

The following schools were selected simply because they are typical of certain kinds of schools and not because they show high efficiency in the matter under discussion. Indeed they are not higher than the average, as far as I know. Other institutions which were investigated, and which might be quoted, show practically the same ratio as those here quoted.

A number of schools showing a low ratio of

[1] Slason Thompson, Bureau of Railway News and Statistics, Chicago, 1910.

compensation of labor to operating expenses might be quoted, but that does not necessarily say anything against the educational efficiency of those schools. The teaching staff may indeed be highly efficient. It simply indicates that too much is being paid for non-essentials as over against teaching, which latter we must consider the main business of the college.

Again it must be borne in mind that in every college in the land there is included in the operating expense a considerable per cent of money which goes to fellowships, scholarships and other "charitable" purposes, as, for example, subsidizing boarding-clubs, college papers, etc. If this money were not thus devoted to "charity" it might be spent for additional productive labor.[8]

Thus the seven institutions quoted show a ratio of 66.5+ per cent compensation of labor to operating expense while the railroads show a ratio of only 62.06 per cent.

	Year Ending	Paid to Labor	Operating Expenses	Per Cent
Throop Polytechnic Institute	Sept. 14, 1909	$50,000.00	$66,100.16	75.6+
Princeton University	July 31, 1910	462,508.42	701,679.25	65.9+
Baker University	July 15, 1910	43,801.67	64,637.61	67.7+
University of Kansas	June 30, 1910	290,788.55	429,655.93	67.6+
University of Okla.	June 30, 1910	93,599.81	125,659.08	74.4+
Howard University (federal institution)	June 30, 1910	55,450.00	119,574.40	46.3+
Marietta College	May 31, 1910	27,405.45	40,375.67	68.1+
			Average	66.5+

Moreover, less of the labor paid out of college funds is non-productive than in the case of the railroads.

And, finally, operating expense in the case of colleges includes a considerable per cent of moneys which are devoted to "charity" by which the public profits.

C. H. HANDSCHIN

THE DIRECTOR VERSUS NEWTON

IN this case the following conversation reported by Professor Maclaurin in SCIENCE, XXXIII., 103, January, 1911, has just come to my notice.

Supt. Your theory of gravitation is hanging fire unduly. The director insists on a finished report, filed in his office by 9 A.M. Monday next, summarized on one page, type written, and the main points underlined. Also a careful estimate of the cost of the research per student hour.

Newton. But there is one difficulty that has been puzzling me for fourteen years, and I am not quite....

Supt. (with snap and vigor). Guess you had better overcome that difficulty by Monday morning or quit.

I have heard since that the conversation was continued as follows, and I wonder if the director was not right.

Newton. I shall continue to use my own judgment about the disposal of my time.

Supt. Yes, but no scientific man should go fourteen years, or even seven, without publishing results. Fourteen years ago you ranked among the leading thousand scientific men, but seven years ago your name was dropped, and this year it was not restored. A city that is set on a hill can not be hid.

Newton. Still I think I am right.

Supt. But the director thinks that, as long as you are accepting pay as a leading scientific man, you should *publish* enough results to keep up your reputation.

CHARLES ROBERTSON

CARLINVILLE, ILL.,
May 1, 1911

AN ENGLISH COURSE FOR ENGINEERING STUDENTS

TO THE EDITOR OF SCIENCE: I am not writing at present to discuss that much-discussed topic, the teaching of practical composition to engineering students, but to explain the first semester work in a course for freshman engineers given at the University of Minnesota, a two-hour course in English which goes hand in hand with a two-hour course in the more practical composition. Two authors are studied, Arnold and Huxley, the former in Gates's "Selections from Matthew Arnold," and the latter in Snell's "Autobiography and Selected Essays by Thomas Henry Huxley" in the Riverside Literature Series.

[8] In the University of Chicago 7.6 per cent. of operating expenses goes to fellowships and scholarships alone. A majority of the larger institutions will show a similar per cent.

To the boy who enters the engineering college fresh from high school, the reading of Arnold's "Sweetness and Light," "Hebraism and Hellenism," etc., is both stimulating and broadening. It forces the freshman to think, to sum up his own ideas concerning his relation to life and the world about him, and perhaps, before he realizes it, his outlook on life has widened. Arnold teaches him to value himself for what he is, to understand what ideal perfection is, to attempt, specialist though he be, to prepare himself for a well-balanced life. The results of Arnold's teaching I have found in impromptu paragraphs on "My Aim in Life," written in the composition class. Here, back of an occasional obvious effort to write what might please the instructor, I have seen evidence of a sincere desire on the student's part to be not only a perfect engineer, but a well-rounded man as well.

The transition to Huxley is made through his controversy with Arnold over the means of getting a cultural education. In Percival and Jelliffe's "Specimens of Exposition and Argument" which the men use in their composition course, is Huxley's address at the opening of Sir Josiah Mason's Scientific College in Birmingham. Arnold's reply is in Gates's "Selections." This controversy gives the freshman a good idea of different views of education, especially of scientific education, and paves the way for Huxley's talks on "A Liberal Education," "Principal Subjects of Education" and "On Improving Natural Knowledge."

The subject-matter and structure of Huxley's addresses appeal to the freshman engineer. This part of the course fits in particularly well with the exposition work in composition. The student learns how to fit his material to his audience, how to outline clearly, how to say things most concisely and in the strongest way, and the fact which the autobiography gives us, that Huxley at first detested writing and speaking, encourages the freshman to emulate Huxley's example and master his mother tongue, that he, too, may best put his ideas before others. As to the subject-matter, what is better fitted to interest the scientific student than "On a Piece of Chalk," "Coral and Coral Reefs" or "The Physical Basis of Life"? Such essays open up for him the great facts of nature which have come in with the "new knowledge."

The fact that this course, joined to the course in practical composition (which is another story), is required of all engineering freshmen and that it is the only course of its kind which they will ever get in college, makes the question of proper subject-matter of vital importance. I should welcome criticism and suggestions.

CHARLES WASHBURN NICHOLS
THE UNIVERSITY OF MINNESOTA,
December 27, 1910

A KINETIC THEORY OF GRAVITATION

TO THE EDITOR OF SCIENCE: In reading the article entitled "A Kinetic Theory of Gravitation," which was published by Dr. Brush in SCIENCE for March 10, I was at once struck with what seemed to me a fallacy in an illustration given early in the discussion. Perhaps the point at issue has been sufficiently discussed by Dr. Kent in SCIENCE for April 21, but since it presented itself to me somewhat differently it may not be out of place to give my line of reasoning.

I refer to the consideration by Dr. Brush of the case of the transportation of a one-pound mass from the surface of the earth to a point of equilibrium between the earth and the moon, at which point there would be no tendency for the body to move either toward the earth or toward the moon. As I understand the argument of Dr. Brush he assumes that in this case there is an apparent disappearance of energy, that there is no gain in the potential energy of the system caused by raising this body from the surface of the earth to the position of equilibrium and that there is, so to speak, nothing to show for the work done in so raising it.

The point that Dr. Brush seems to have overlooked is that attraction between two bodies is mutual. If the pound mass in the position of equilibrium is attracted by earth

and moon it in turn attracts both earth and moon The tendency for the earth and moon to approach each other is greater than before the pound mass was raised from the surface of the earth, the potential energy of the system is increased by an amount equal to the energy expended in raising it and there is no more a disappearance of energy to be accounted for than in the simpler case where a mass subject to no attraction but the earth's is raised above the earth

E S MANSON, JR

COLUMBUS, OHIO,
April 29, 1911

SCIENTIFIC BOOKS

Œdema A Study of the Physiology and Pathology of Water Absorption by the Living Organism By MARTIN FISCHER, M D Pp 209 New York, John Wiley and Sons 1910

A trenchant alternative to current and generally accepted ideas of the distribution of water in the organism is presented by Fischer in this essay The familiar reference to filtration, diffusion and osmosis as explanatory factors is notably absent and, instead, the part played by the colloids in the cells and body fluids is emphasized That some colloids, such as gelatine, for example, are able to take up water and thus enormously to increase their volume is common experience Such "hydrophilic" colloids Fischer has investigated with reference to the conditions which cause them to take in water or to give it forth The degree of swelling of the colloid depends on its nature and also on the character of the solution in which it is placed Thus both gelatine and fibrin swell more in alkaline or acid solutions than in water, both have the amount of swelling in acid or alkaline solutions reduced by the presence of electrolytes, and in both the addition of non-electrolytes fails to exert the checking effect produced by electrolytes By extensive experiments Fischer has demonstrated that the body tissues, represented by muscle and the eyes, when immersed in water, or in acid and alkaline solutions, or in combinations of acid and alkaline solutions with various electrolytes, behave in a manner quite analogous to gelatine and fibrin

On the basis of these experiments the suggestion is offered that œdema is induced whenever, in the presence of an adequate supply of water, the affinity of the colloids of the tissues for water is increased above what we call normal Particularly by the accumulation of acids in the tissues is the affinity for water increased Thereupon Fischer proceeds to show that states in which œdema develops are accompanied by an abnormal production of acid, that under such circumstances œdema can be reduced by the same agencies (electrolytes) which decrease the affinity of hydrophilic colloids for water, but remains unaffected by non-electrolytes, and that experimental production of acids in tissues results in the development of œdema

The argument thus devised for the explanation of œdema in general is applied to the peculiar phenomena of œdema in special organs, and is then extended to other biological phenomena in which the transfer of water plays an important rôle, as in hæmolysis, growth and urinary secretion

The experimental procedures on which the conception described in this volume is founded are of the utmost simplicity, and can be readily tested by any one Fischer's application of these simple tests to conditions in the body is made with much ingenuity and in many instances with compelling conviction To what extent the process can be used to explain certain results of experimental procedures which cause increased production of lymph, or which vary the amount of urine secretion, remains to be seen Certainly the conception is highly suggestive, and well worth putting to further test

The subject is expounded by Fischer with clearness, with enthusiasm, and with evident assurance of the adequacy of the theory to meet the demands that can be put upon it The essay was awarded the Nathan Lewis Hatfield Prize by the College of Physicians of Philadelphia in 1909.

W B CANNON

Introductory Notes on Quantitative Chemical Analysis. By CHARLES WILLIAM FOULK, Professor of Analytical Chemistry in the Ohio State University. Second edition, revised and enlarged. Columbus, Ohio. 1910.

This is a very detailed but simple manual for college work in quantitative analysis. 130 out of 239 pages are given to general principles and methods. Detailed description of 14 practical analyses occupies the remainder of the volume.

E. R.

Qualitative Chemical Analysis, Organic and Inorganic. By F. MOLLWO PERKIN, Ph.D., Late Head of the Chemistry Department, Borough Polytechnic Institute, London. Third edition. New York, Longmans, Green, & Co.

This is an excellent manual of systematic, qualitative, inorganic analysis followed by a manual of qualitative organic analysis, the latter necessarily consists chiefly of special tests. It will doubtless be found useful.

E. R.

Publications of the Astronomical and Astrophysical Society of America. Vol. 1, pp. xxvii + 347. Ann Arbor, Mich. 1910.

This volume, published by authorization of the society at its tenth annual meeting in 1909, is devoted (after a brief introductory sketch) to accounts of its meetings, including the two informal conferences which preceded its organization, and to abstracts of the papers presented. The last occupy by far the greater part of the work. To review them would be practically to give an account of the astronomical work done in this country in the last twelve years.

Perhaps the strongest impression left after glancing over them is of the advance that has been made, both in the means and results of observation, since the first conference was held at the dedication of the Yerkes Observatory in 1897.

To the members of the society nothing is likely to be more prominent in memory than the inspiration resulting from its meetings, with their abundant opportunity for conference and discussion, and the cordial hospitality shown at the various places of meeting.

HENRY NORRIS RUSSELL

PRINCETON UNIVERSITY

SPECIAL ARTICLES

THE "DILUTE" FORMS OF YELLOW MICE[1]

A MODIFIED variety of the dark-eyed black mouse exists in the dilute black or "blue" of the fanciers. When the hairs of these dilute black animals are examined microscopically and compared with those of ordinary or intense blacks, it will be found that a reduction in the number of the pigment granules has taken place. It is not a large reduction, but is nevertheless sufficiently pronounced to be recognized with considerable ease. The same relation is observable between the intense and the dilute varieties of brown, known as "chocolate" and "silver-fawn," respectively, as well as in the corresponding varieties of black-agouti and brown-agouti.

The hairs of cream, or light yellow, mice, as compared with those of ordinary yellow mice, show, when examined microscopically, a very pronounced reduction in the amount of yellow pigment. This reduction is clearly more complete than that seen in the dilute black or dilute brown forms. Moreover, the last two forms named are remarkably constant in their degree of dilution, while cream forms may vary through deep creams to light yellows and from these to deep red-orange forms showing a full complement of pigment granules.

It is known that in the case of brown and black the dilute condition behaves as an independent unit-character, and so can be transferred in crosses from brown to black or *vice versa.* The dilute condition is also recessive to the intense, in crosses, so that dilute animals bred together produce only dilute offspring.

The question now arises whether "cream"

[1] Contributions from the Laboratory of Genetics, Bussey Institution, Harvard University, No. 11.

is a dilute form of yellow corresponding in nature to the dilute forms of black and brown A very simple and direct test of this matter is obtained by breeding "cream" animals together

Cream-colored, like all other shades of yellow mice, are regularly heterozygous, producing black or brown pigmented young as well as those which are yellow, the yellows being to the non-yellows approximately as two to one[5] Now if the "cream" condition of yellow is produced by the same factor as the dilute condition of black and brown, the "creams" bred together should produce non-yellow young all of which are *dilute*, since, as stated, dilution is recessive in nature

Such, however, is not the case Cream animals mated together produce only cream or light-colored yellow offspring, but the black or brown pigmented young which they produce are commonly of full intensity Accordingly, it follows that the "cream" modification of yellow is different in nature from the dilute modification of black and must be produced by a different factor

This fact being established, search was begun for a type of yellow which when bred by itself would produce yellows and dilute forms of black and brown Such yellows should, when obtained, be distinguishable from the intense yellow as well as the "cream" type, and should show on microscopic examination of the hair a condition of pigment reduction equal in amount to that seen in the dilute black or dilute brown forms

Such yellows have been obtained They may be deep red, light cream, or any of the intermediate gradations, but they possess an extremely characteristic washed-out dull appearance, which serves to distinguish them clearly from intense forms, even though these be extremely light colored.

Since this form of yellow occurs in all the gradations from "red" to "cream," it is apparent that it represents an independent form of pigment reduction; and since, unlike the "cream" reduction, it is transferable to black or brown, it is safe to class it as the *dilute form of yellow*

The fact that black and brown pigment is present in agouti animals in a presumably constant degree of intensity and that the yellow pigment may independently vary in these animals from cream to deep red, may possibly serve to explain the marked variations seen in the type known as intense black agouti (golden agouti)

A table showing the result of crossing "creams" (light yellow) *inter se* follows

TABLE I

Parents, "cream" × "cream",
Offspring, "cream" 31, black 10, brown 14
(*light yellow*) (*intense*) (*intense*)

From Table I it will be seen that non-yellow young of a dilute character are not produced by mating cream-colored animals *inter se* On the other hand, such young have been produced by dilute yellows crossed *inter se*, as shown by Table II

TABLE II

Parents, dilute yellow × dilute yellow,
Offspring, dilute yellow 95, dilute non yellow 52.

Further, when dilute yellows are mated with dilute non-yellows the non-yellow offspring are all dilute (see Table III)

TABLE III

Parents, dilute yellow × dilute non yellow,
Offspring, dilute yellow 38, dilute non yellow 37.

In the foregoing account dark-eyed yellows are alone used in computing the numerical results Experiments with pink-eyed yellow forms have been conducted, but the data have not yet been tabulated

C C LITTLE

May 22, 1911

[5] See SCIENCE, N S, Vol. XXXII, No 833, pp 868–870

DIMORPHISM OF THE GAMETES OF ŒNOTHERA[1]

PROFESSOR DE VRIES[2] has brought to light a

[1] Read before the Botanical Society of Washington, May 2, 1911

[2] "Ueber doppeltreziproke Bastarde von *Œnothera biennis* L und *O. muricata* L.," in *Biologisches Centralblatt*, 31: 97–104, No 4, February 15, 1911.

remarkable form of dimorphism of the gametes of several species of evening primrose If reciprocal hybrids are made between, say, *Œnothera biennis* and *O muricata*, the resulting hybrids are very unlike and strongly patrocline, in both cases presenting only slight traces of any influence by the female parent Detailed investigations now under way by Professor de Vries show that the ovules and pollen grains carry quite different hereditary tendencies The common *Œnothera biennis* represents the form inherited through the pollen, the characters carried by the ovules being recessive If *O biennis* is crossed with pollen of another species over which it is dominant, the result is to bring into expression the form inherited through the ovules, which de Vries calls the *conica* form This form is obtained if *Œnothera biennis* is crossed with pollen of *O muricata*, *O Hookeri*, *O strigosa*, etc Similarly, if *Œnothera muricata* is pollinated with *O biennis* (Chicago form), *O Hookeri* and *O strigosa*, it yields what de Vries calls the *frigida* form which represents the form of *O muricata* inherited through the ovules

The ordinary form of *O biennis* represents what de Vries calls the pollen picture of this species, the pollen form (*biennis*) being dominant over the ovule form (*conica*) The same is true of *O muricata*, the ovule form (*frigida*) being recessive to the pollen form (*muricata*)

This property of producing gametes having diverse hereditary qualities is termed by Professor de Vries "*Heterogamie*," but as this term is already used in many different senses it seems best to propose instead a new term, *allogametism*, after the analogy of such words as allotropism

The pollen grains and ovules of *Œnothera biennis* and *O muricata* would constitute *allogametes*

If B represents *Œnothera biennis*, M, *Œnothera muricata*, H, *Œnothera Hookeri*, and L, *Œnothera Lamarckiana*, the second term being the male parent in each case, some of the remarkable results of allogametism are as follows:

Hybrid BM = *conica* (ovule picture of *O biennis*)
Hybrid MB = *biennis* (pollen picture of *O biennis*)
Hybrid MH = *frigida* (ovule picture of *O muricata*)
Hybrid LM = *muricata* (pollen picture of *O muricata*)

In such allogametic species of *Œnothera* the diversity of the gametes of the two sexes does not become apparent unless reciprocal hybrids are made with another species, whereupon very different results are obtained, depending upon which species is used as the female parent

In case the reciprocal hybrids of the same two parents are crossed, what de Vries calls double reciprocal hybrids result, thus

$$BM \times MB = B,$$
$$MB \times BM = M$$

In such cases the "peripheral"[3] grand parent shows complete dominance, while the "central"[3] grand parent is eliminated, thus

$$B(M) \times (M)B = B,$$
$$M(B) \times (B)M = M$$

If a patrocline hybrid is crossed with pollen of the paternal species, what de Vries calls *iterative* hybrids result, exactly like the first hybrid and very like the paternal species, thus

$$MB \times B = MB = B,$$
$$B \times BM = BM = M$$

The central term in the formula is eliminated in this case, $M(B) \times B = MB = B$

If a patrocline hybrid be crossed with pollen of the mother species, what de Vries calls *sesqui-reciprocal* hybrids result in which the grandpaternal species is eliminated, thus:

$$MB \times M = M,$$
$$BM \times B = B.$$

The central term in the formula is again eliminated, $M(B) \times M = M$

Not all the characters of the species were found to be transmitted allogametically. In

[3] So called from the position in the above formulæ

O biennis and *O muricata*, however, the only exception seems to be in the size and form of the petals

The very interesting discovery was made by J M Geerts[4] that approximately half the ovules and half the pollen grains of the allogametic species of *Œnothera* are abortive It is suggested that in case of *Œnothera biennis* only those ovules that carry the *conica* form develop, those that should carry the *biennis* form aborting On the other hand only those pollen grains which carry the *biennis* form mature, those that should carry the *conica* form failing to develop

WALTER T SWINGLE

STUDIES IN ARTERIOSCLEROSIS

MUCH has appeared in the literature in recent years upon the etiology and process of development of arteriosclerosis Many observations have been made upon the human subject and also in experimental animals, of points co-relating certain factors with the production of disease in the arterial tree In most instances these factors have been carefully studied by competent observers and in many instances the results have been verified by others

The gathering of facts concerning arteriosclerosis is quite simple—the interpretation of these involves much difficulty In carrying out any experiment or in offering reasons for a given result, we are constantly reminded of the manifold factors which enter a given experiment or which are naturally present. Often our experiment on animals only induces altered conditions which indirectly bring about the result we are seeking That the greatest care must be exercised in drawing inferences from animal experimentation is well illustrated in studies upon arteriosclerosis

Recently Levin and Larkin[1] have published the results of their experiments on dogs, in which by producing an arterio-venous anastomosis between the external jugular vein and the external carotid artery, they arrive at the sweeping conclusion that "arteriosclerosis can not be artificially induced in a previously healthy blood-vessel by a change in the blood pressure alone" To *this type* of conclusion we must take exception

Levin and Larkin, experimenting on ten dogs, joined the external carotid artery to the external jugular vein In two of these dogs thrombosis occurred close to the line of suture in the vessels All but two of the remaining eight animals received injections of adrenalin at varying periods These eight dogs, which form the positive results and from which the above positive statement respecting arteriosclerosis was made, were allowed to live 102, 38, 72, 15, 124 and 58 and 44 days, respectively

No one, who has studied diverse pathological lesions, will deny that the distribution of various lesions in organs is not uniform in the animal world Man is particularly subject to lesions of the circulatory system—a condition not so frequent in lower animals Rabbits and horses occasionally suffer from arterial lesions—more often seen in the older animals and in certain breeds Dogs and cats rarely develop lesions in the arteries, even under the most trying circumstances

This varying susceptibility still awaits an explanation, but in the face of our ignorance in the matter, we must assume the greatest care in drawing broad conclusions or in proposing far reaching principles Negative experimental results for the dog have no positive bearing upon experimental facts observed in other animals

Much criticism is offered against the use of the rabbit for experiments upon the circulatory system The comment has been that spontaneous arterial disease occurs in this animal And yet none of the critics offer any suggestion for the cause of this spontaneous lesion! Properly selected animals and controlled experiments can reduce the error of "spontaneous" disease to almost a vanishing point The very feature, in the rabbit, of readily reacting in its arterial tree to different

[4] Geerts, J M, "Beitrage zur Cytologie und der partiellen Sterilibat von *Œnothera Lamarkiana*," in *Recueil des travaux botaniques néerlandais*, 5: 93–208, pl 5–22 (N 2–4, June, 1909), also published as a separate article

[1] *Jour Exper Med*, 1911, XIII, p 24

noxæ, determines its usefulness for studying the diseases of the circulation.

In the experiments of the above-cited authors, the observations were made upon the venous segments of the anastomosis Here although in only some of the animals the vein was noted to be dilated, it is concluded that an increased blood pressure existed in all It is not at all clear to what extent the blood pressure was increased when the external carotid and external jugular were united With the free anastomosis which exists (varying much in individual animals), between the venous channels of the neck, it is possible that an increase of pressure exists for only a short period after the successful anastomosis[8]

It is further to be pointed out that various observers have recorded that periodic and intermittently increased blood pressures have quite a different effect upon the blood vessels than a constant and continuous one The periodically increased pressure is found commonly in man, and if we may draw any conclusions from the finding of occupation sclerosis (right radial sclerosis in the blacksmith, femoral sclerosis in the policeman), it is that the periodic increase of pressure leads to degenerations and sclerosis in the arteries

Finally, but of primary importance, the results of observations on veins can not be utilized in drawing conclusions about arteries, as has been done by Levin and Larkin

Oscar Klotz

University of Pittsburgh,
February, 1911

[8] See Carrel and Guthrie, "Surg. Gynæ. and Obstet," 1906, Vol. II.; and Watts, *Bull Johns Hopkins Hosp.*, 1907, Vol XVIII.

PRESENCE OF ARSENIC IN FRUIT SPRAYED WITH ARSENATE OF LEAD

The spraying of fruits with an arsenical has been practised for a number of years in the control of insects which destroy by eating. The form in which arsenic was first used was Paris green, which, however, proved, for the most part, to be more or less injurious to foliage and fruit on account of the soluble character of the compound. Only within recent years has arsenate of lead come into use The main reasons for its use as recommended by entomologists was its greater purity and insolubility in water During the past three years the writer has had occasion to question the use of arsenate of lead as commonly found on the market Many brands do not show sufficient uniformity in arsenic content, nor is the arsenic found in the proper combination with the lead. When lead nitrate and disodium arsenate or lead acetate and disodium arsenate are combined at least three forms of arsenate of lead may result, namely, ortho-arsenate of lead ($Pb_3(AsO_4)_2$), pyro-arsenate of lead ($Pb_2As_2O_7$) and meta-arsenate of lead ($(PbHAsO_4)_2$) The last named compound is very injurious to foliage and fruit under certain climatic influences, and the pyro-arsenate of lead may become so in the presence of water containing soluble chlorides, sulphates or carbonates Very few of the waters commonly used to apply arsenate of lead are pure, hence injury may result, although the compound if used with chemically pure water will produce no injury The ortho-arsenate of lead, however, is practically insoluble in neutral and alkaline solvents

Besides any apparent injury, such as the spotting or burning of the fruit and foliage, a certain amount of arsenic may be absorbed by the fruit without showing any injury at the time The occurrence of certain spots on apples held in storage has occupied the attention of the writer for some time. Upon examination, such fruits were found to contain appreciable quantities of arsenic The badly red-spotted and black-spotted fruits showed approximately twice as much arsenic as fruits from the same lot which showed no spotting. A ten-gram sample of badly spotted apple skin showed 0.05 of a milligram of metallic arsenic. One large Spitzenburg apple showed a total of 0.3 milligram of arsenic calculated as As_2O_3. The fruits were carefully washed so as to exclude from analysis all arsenic that adhered to the surface.

It has also been noted by the writer that certain papers used to wrap apples and pears, a practise common on the Pacific coast, con-

tain, very frequently, small amounts of arsenic, as well as other substances which may or may not have an injurious effect. It is quite well known that small quantities of arsenic have a tendency to hasten the ripening process in fruits One instance of particular interest has been noted A certain shipment of pears was wrapped with two different brands of paper The pears were of one variety, all from one orchard, and were kept under exactly the same conditions and treated in every way the same, excepting that about one half of the shipment was wrapped with one brand of paper and the rest with another brand After the fruit had been in storage for some time it was found that the ripening process in one lot was much in advance of the other, the other lot remained normal After an examination of the whole shipment it was found that the condition of the fruit corresponded exactly with the brand of paper used. It would seem from this that fruit growers should pay particular attention to the quality of paper used for wrapping fruit as well as the quality of arsenate of lead used in spraying the fruit

P J O'GARA

THE AMERICAN PHILOSOPHICAL SOCIETY

THE annual general meeting of the society was held in the hall of the society, Philadelphia, April 20, 21 and 22, at which about sixty papers were presented on scientific and literary topics

President W. W Keen, LL D, and Vice president E C. Pickering took turns in presiding at the various sessions

It has been the custom for several years to devote one half day session to a symposium on some special topic in science This year the subject was "Modern Views of Matter and Electricity," and the following papers bearing on this general topic were offered "The Fundamental Principles," by Professor D F Comstock, of Boston, "Radioactivity," by Professor B B Boltwood, of New Haven, "Thermionics," by Professor O W Richardson, of Princeton, "The Constitution of the Atom," by Professor H. A Wilson, of Montreal. The general conclusion seems to be that the atom of matter, groups of which compose the molecules of different substances, is built up of much smaller parts, known as electrons, identical with the smallest unit of negative electricity Sir J J Thomson's theory of the atom assumes also a spherical form of positive electricity, throughout which are imbedded the electrons in different numbers according to the kind of atom It was also explained how it is possible to estimate the actual number of electrons in an atom of any given kind As the inertia of an electron emitted from the atom of a radioactive substance, such as radium, has been experimentally proved to be a function of its speed, the evidence is strong that all inertia or mass may be electrodynamic in its nature

At the opening session on Thursday the following papers were read

Notes on Cannon Fourteenth and Fifteenth Centuries CHARLES E DANA, Philadelphia

The first absolutely reliable, contemporaneous account we have of cannon is contained in an edict, still to be seen, in Florence, Tuscany, dated 1326 What these cannon looked like or did we shall never know, but with them begins the authentic history of ordnance, back of them is only legend

Powder was in those early days, as its name implies, a dust, it contained the charcoal and sulphur of to day, as well as the saltpeter, but far too small a quantity of the last, on account of the difficulty in procuring it The cost, in the middle of the fourteenth century, was almost prohibitive, cheap at twenty five dollars a pound, in money of to day

The next mention of cannon is of some at the Tower of London in 1338, amongst these were several breech loaders Another, in the same year, called a "pot for hurling arrows," was the pride of the arsenal of Rouen, France The charge for this mighty engine of war was less than an ounce of the badly proportioned dust of that day—termed powder

It is often asserted that three field guns were used by the English at Crécy, where, in 1346, they gained so tremendous a victory One must always remember that a large body of English archers was there present Every man of them was a dead shot, firing ten or more arrows a minute from his "longbow", the effective range was two hundred and fifty yards, every "cloth yard arrow" was an armor piercing projectile. Of what use three absurd pop-guns would have been it is difficult to imagine. The interest is purely antiquarian, as these would have been the first field-artillery mentioned in history. That cannon were

used at the siege of Calais, which immediately followed Crécy, there is no doubt whatever

By the end of the fourteenth century huge bombards, throwing stone balls of two hundred pound weight, were common, later, stone balls weighing a thousand pounds, requiring a gun caliber of over thirty inches, were in use

The quick firing, breech loading guns of the fourteenth and fifteenth centuries, when they were provided with at least four chambers, which chambers looked much like a beer mug and contained the powder charge, could be fired about once in two minutes These were most effective at sea, fired from the tops, just as our quicker firing guns are, they were used for clearing the deck, loaded with bullets, rusty nails and a general assortment of scraps they were worthy of their name—"murtherers"

The great bombards, and many of the smaller guns in the fourteenth century, were built of longitudinal wrought iron bars, over which heavy iron rings or bands were driven The breech, containing the powder-charge, was usually forged, the caliber being about a third that of the chase The powder charge was about one eighth to one ninth the weight of the stone projectile In spite of the smallness of this the bombard had a bad habit of bursting, spreading death in all directions except where it was intended to

The field guns at the end of the fifteenth century would not have looked very strange in, say, 1800 For it must not be forgotten that the guns used by Nelson at Trafalgar (1805) differed but little from those used by Howard and Drake against the Spanish Armada, over two hundred years earlier

The Cost of Living in the Twelfth Century and its Effects DANA C MUNRO, University of Wisconsin

The rise in the cost of living in the twelfth century was due to a change in the standard of living Acquaintance with the east, through the crusades, led to a desire for more costly clothing, and fashion began its despotic sway More luxurious dwellings, oriental spices and other products became common The amount of money available was greatly increased by the coining of the gold and silver which had been hoarded, by the more rapid circulation of the money, and especially by the use of instruments of credit which became common in the twelfth century

An era of extravagance ensued which is well depicted in the literature of the age The average noble was unable to increase his income, which was derived from fixed customary payments Consequently, to meet his new needs he was compelled to borrow at ruinous rates of interest The lender was frequently a Jew and much of the ill will toward the Jews is to be traced to the hostility of the borrowers who were hopelessly in debt

The peasants profited by the opening of more markets for their agricultural products and were sometimes able to gain their freedom by the payment of a small lump sum when the lord of the manor was hard pressed for money The merchants profited most by the increase of trade and became factors in the political life of the day Sumptuary laws were frequent but ineffective

As yet too little attention has been paid to this change in the standard of living and its effects There is a great mass of material in the shape of documents, such as the Pipe Rolls, *e g*, and there are many references in the contemporary literature There is an opportunity and need for a number of students to investigate various phases of the subject This is one of my reasons for presenting this subject here

Elizabethan Physicians FELIX E SCHELLING, University of Pennsylvania

The Relations of the United States to International Arbitration Hon CHARLEMAGNE TOWER, Philadelphia

The Early German Immigration and the Immigration Question of To day M D LEARNED, University of Pennsylvania

On the Solution of Linear Differential Equations by Successive Approximations PRESTON A LAMBERT, Lehigh University

Generalizations of the Problem of Several Bodies, its Inversion, and an Introductory Account of Recent Progress in its Solution E O LOVETT, Rice Institute

On the Totality of the Substitutions on n Letters which are Commutative with Every Substitution of a Given Group on the Same Letters. G A. MILLER, University of Illinois (Introduced by Professor C L Doolittle)

Report on the Second Conference of the International Catalogue of Scientific Literature L C. GUNNELL, Smithsonian Institution (Introduced by Dr Cyrus Adler)

Moreau de Saint Méry and the other French Exiles Some of our Forgotten Members

One of the results of the French Revolution was that many of the exiles from France and its West India colonies found a harbor of refuge in

Philadelphia, and some of the most notable among them became members of the American Philosophical Society

Talleyrand, Noailles, Chastellux, Rochefoucauld Liancourt, Brissot and Volney are known by their books and by their subsequent career in France

One of the most active in the Philosophical Society was Moreau de Saint Mery, now almost forgotten, but recently rescued from oblivion by the publication of some of the documents from his large collection of 250 volumes, in the *Proceedings* of the Wisconsin Historical Society and the *Canadian Archives*

Born in the island of Martinique in 1750, dying in Paris in 1819, he was employed in the royal government of Saint Domingo, and published a collection of the laws of the French West Indies He sent scientific papers to the American Philosophical Society, and was elected a member in 1789 Driven from France, where he was a member of the First Convention, representing the West Indies colonies, he found refuge in Philadelphia

Here he opened a book store at Second and Walnut Streets, published works of his own on Saint Domingo, one of them translated by William Cobbett, then living in Philadelphia, and his own translation of a book on its prisons by Rochefoucauld Liancourt, and one on China by VanBraam, "of China Hall near Bristol," who had been a member of a Dutch embassy in China, and brought here a large collection of curios from China

Saint Mery printed a catalogue of books in French, German, Italian, Latin and Greek on sale in his book store, which is quite remarkable for its extent at that period His book store was quite a meeting place for other French exiles of all parties, Royalists, Girondins, Jacobins, and he and they were frequent visitors to the Philosophical Society and contributors to its *Proceedings*

Returned to France through the influence of his relative, Josephine, Napoleon gave him in succession important positions, and, as historiographer of the Marine Department, he made the large collection of documents relating to the history of France in America, which is now one of the most important series in the great French Archives

He was a diligent collector, an intelligent observer and a notable character in his day and generation, and his stay in Philadelphia was not without influence on both countries

He followed Talleyrand in guiding Napoleon to sell to the United States the vast and unknown Louisiana Territory, so important in the later history and growth of the United States

When France lost its holdings on the American continent, Saint Mery began to collect historical documents relating to the period when France controlled Canada and Louisiana and disputed with Great Britain possession from the St Lawrence to the Gulf of Mexico

Now in his collection, historical students in Canada and Wisconsin find the material for publication on the history of France in America His zeal for rescuing from destruction these sources of history is now receiving acknowledgment, and his name figures in the works of Aulard and Thwaites, who find in his collection material of great value for their recent contributions to our knowledge of history Apparently a modest man, his service to the American Philosophical Society, his contribution of his own papers and books and objects of interest for its collection, and in bringing to its meetings many of his fellow exiles, were of value Some of his countrymen became members of the society, thanks to his introduction, and among them were those who played a large part in the history of France His own collection of historical documents throws much light on the early French settlements in the United States, and makes the best memorial of his zeal in spreading useful knowledge

The session on Friday morning was devoted especially to botany, chemistry and astrophysics, and the following papers were presented

Study of the Tertiary Floras of Atlantic and Gulf Coastal Plain EDWARD W BERRY, associate in paleontology, Johns Hopkins University (Introduced by Dr J W Harshberger)

The Desert Group Nolineæ (illustrated) WILLIAM TRELEASE, director of the Missouri Botanical Garden, St Louis

The Blueberry and its Relation to Acid Soils F E COVILLE, U S Department of Agriculture (Introduced by Dr J W Harshberger)

Experiments covering a period of five years, with many kinds of soil and nutrient solutions, showed that in all so called fertile soils the blueberry either does not thrive or it dies outright In an acid peaty soil, such as occurs in bogs or sandy woods, it grows luxuriantly Ordinary plants suffer in such soils from nitrogen starvation The blueberry, however, bears on its roots a fungus which appears to act in a beneficial manner by furnishing nitrogen to the plant

On the basis of these experiments the blueberry has now been put into actual field culture on a small scale, with every prospect that it will be

made commercially successful In the field plantings bushes grown from the seed have been chiefly used, but the propagation of superior varieties by layering and by cuttings is now in progress, one of the varieties having berries over half an inch in diameter

The acid lands on which the blueberry grows best are commonly regarded as of little value agriculturally Blueberry culture offers a special means for the utilization of such lands

The blueberry is not alone in its ability to thrive in an acid soil. Experiments with various other plants indicate similar characteristics For example, the wild trailing arbutus, which has been regarded as exceedingly difficult of cultivation, grows luxuriantly when potted in the acid peaty soil found so successful for the blueberry Exceptionally beautiful flowering plants have been grown from the seed in less than two years There is no reason why trailing arbutus can not be added to the choice potted plants of the florists' trade

It is impossible to foretell to what extent other useful plants than the blueberry will be found to be adapted to acid soils The cranberry is clearly an acid soil plant. Dr H J Wheeler, of the Rhode Island Agricultural Experiment Station, has shown that the strawberry, the potato, rye, lupin and buckwheat grow as well or a little better without the use of lime In other words, they are acid soil plants

It is not altogether a dream to foresee the development of a special acid land agriculture, in which the rotations shall include only such crops as prefer an acid soil or are indifferent to acidity

The New Cosmogony

The Extension of the Solar System beyond Neptune and the Connection Existing between Planets and Comets.

The Secular Effects of the Increase of the Sun's Mass upon the Mean Motions, Major Axes and Eccentricities of the Orbits of the Planets· T. J J. SEE, Mare Island, Cal

Extension of Our Knowledge of the Atmosphere· A L. Rotch, Harvard University (Introduced by Professor W M Davis)

One Hundred and Seventy five Parabolic Orbits and other Results deduced from over 6,200 Meteors· C P, OLIVIER, of Charlottesville, Va. (Introduced by Professor Cleveland Abbe)

The Solar Constant of Radiation: C. D ABBOTT, Smithsonian Institution (Introduced by Dr C. D. Walcott.)

If we had no eyes we should still know of the sun by the feeling of warmth The most exact measurements of the intensity of the rays of the sun, whether they be visible to the eye or affect the photographic plate or not, are made by an electrical thermometer called the bolometer This instrument is so sensitive that a millionth part of a degree change of temperature is recorded by it For seven years the bolometer has been used by the staff of the Astrophysical Observatory of the Smithsonian Institution to measure the solar constant of radiation This constant represents the number of degrees (centigrade) which one gram of water would rise in temperature if all the solar radiation which could pass through an opening one centimeter square outside the earth's atmosphere, but at the earth's mean distance from the sun, could be used for one minute to heat the water As all life and almost all forces on the earth depend on the supply of solar rays, the solar constant of radiation is at least equal in importance to the knowledge of the sun's distance

The value of the solar constant was unknown within wide limits only five years ago It is now believed to be within 1 per cent of 1 93 calories per square centimeter per minute Measurements made at Washington (sea level), Mt Wilson (one mile elevation and Mt Whitney (nearly three miles elevation) agree in fixing this conclusion

Nearly 500 determinations have been made They indicate that the value is not really a "constant," but fluctuates about the mean just given within a range of 8 per cent This conclusion means that the sun is a variable star. It is hoped soon to verify it completely, and it may prove for meteorology hardly less important than the determination of the mean value of the solar constant itself.

Some Curiosities in the Motions of Asteroids: ERNEST W BROWN, professor of mathematics, Yale University.

Spectroscopic Proof of the Repulsion by the Sun of Gaseous Molecules in the Tail of Halley's Comet: PERCIVAL LOWELL, director of Lowell Observatory, Flagstaff, Ariz.

Self luminous Night Haze: EDWARD E. BARNARD, astronomer, Yerkes Observatory, Williams Bay, Wis.

Some Peculiarities in the Motions of the Stars: W. W CAMPBELL, director of Lick Observatory, Mt Hamilton, Cal.

Taking a Census of the Chemical Industries CHARLES E. MUNROE, professor of chemistry, George Washington University, Washington.

Some Recent Results in Connection with the Power of Solutions to Absorb Light HARRY C JONES, professor of physical chemistry, Johns Hopkins University

The Properties of Salt Solutions in Relation to the Ionic Theory ARTHUR A NOYES, professor of theoretical chemistry, Massachusetts Institute of Technology (Introduced by Dr James W Holland)

The Atomic Weight of Vanadium GUSTAVUS HINRICHS, of St Louis (Introduced by Professor Amos P Brown)

Quinazolone Azo Dyestuffs A New Group of Azo Dyes MARSTON TAYLOR BOGERT, head of School of Chemistry, Columbia University, New York

The Friday afternoon meeting was devoted mostly to geology and to biology

The following papers were read

Shore and Off shore Deposits of Silurian Age in Pennsylvania GILBERT VAN INGEN, of Princeton University (Introduced by Professor W P Scott)

The lithological and faunal characteristics of the Silurian formations were briefly described and the changes in these features were interpreted in terms of their geographic positions in respect of the shore lines and open seas of that time The marine oolitic iron ores of the center of the basin were shown to change in shoreward directions to hematitic sandstones of much greater thickness and finally to red and olive quartzites, which are equivalents of part of the Shawangunk grit of the northeastern Appalachians The conclusion is reached that the Shawangunk grit is of Medina-Clinton Niagaran age and all older than the Salina to which it has lately been referred

Tertiary Formations of Northwestern Wyoming WILLIAM J. SINCLAIR, of Princeton University (Introduced by Professor W B Scott)

Mr Sinclair gave a rapid review of the stratigraphy of the Wind River and Bighorn basins, followed by a discussion of the color banding in the Eocene clays, which he correlated with climatic changes.

On a New Phytosaur from the Triassic of Pennsylvania · WILLIAM B SCOTT, of Princeton University

Alimentation of Existing Continental Glaciers · W. H. HOBBS, of University of Michigan

It was in the Alps of Switzerland that the early studies and by far the larger number of subsequent investigations of glaciers have been made. The Swiss type of glacier is one of the most diminutive, but as the theory of former continental glaciation was derived from these studies of puny glaciers, it is not surprising that their attributes were carried over unchanged to the reconstructed extinct types thousands and even tens of thousands of times larger, and this before any continental glaciers had actually been studied The recent explorations of Norwegian, German, Swedish and Danish explorers, but more than all of Peary in Greenland, and of Scott, Nordenskiold, von Drygalski and others, but especially of Shackleton in Antarctica, have at last afforded us with observations upon the existing continental glaciers When these reports are carefully studied and compared, it is found that as regards their form, their erosional processes, and especially their nourishment and waste, continental glaciers are as different as possible from those of the Alpine type Instead of being nourished by snow precipitated from *surface* air currents which are forced to *rise*, their snow supply is derived from the fine ice grains contained in *high level* cirrus clouds which have been *drawn down* to the glacier surface, been melted, and there reprecipitated This action is the work of a refrigerating air engine which is developed directly by the snow-ice mass itself The paper is illustrated by lantern slides

On the Formation of Coal Beds J J STEVENSON, University of the City of New York.

Two hypotheses, presented to explain accumulation of coal in beds, have been in conflict for almost a century and a half One asserts that the vegetable material was transported by running water and deposited, as were the enclosing sandstones and shales, the other assigns to transport an insignificant share and maintains that the vegetation grew where the coal bed is now found

The disputants agree practically on what may be termed facts of observation, such as the nature of the material and the structure of the beds, but the parting comes in the effort to explain the phenomena by reasoning backward from known conditions of our own time. There is room for surprise when one discovers that phenomena, regarded by one writer as final arguments in support of his hypothesis, are regarded by another as equally final in support of the contrary doctrine. Too often, the reasoning is from the hypothesis to the facts and the *a priori* argument seems to be based on an imperfect knowledge of present phenomena or on a purely local study.

Ten years ago I began systematic study of conditions throughout the vast Appalachian basin, hoping to find there enough information for solution of the problem involved, but the results were far from sufficient and study of other regions became necessary. This required examination of hundreds of publications, large and small—and the examination is still far from complete, for the literature, to speak moderately, is sufficiently extensive and, within the last quarter century, sufficiently intensive. While plodding through it, I discovered that much of what has been regarded as new in later days is really very old. The work of earlier students, buried in publications of learned societies, has passed into oblivion. In some instances, important observations have been recorded incidentally in discussion of other topics. Often, the work of an investigator is known only through citations, which, separated from their context, are apt to give a wrong conception of the author's opinions. As the examination advanced, I became convinced that it would be well to present, without comment, a synopsis of each work that seemed to have an important bearing on the subject, that the development of opinion might be made clear and that proper credit might be assigned to men who did excellent work with meager opportunity. Such a presentation seemed also likely to serve as a proper foundation for the general discussion and it is offered here as the first part of a monograph upon the formation of coal beds.

As the study advanced, the elements of the problem were found to be more numerous and more complicated than had been supposed. It has become essential to consider in detail some subjects of which many of the disputants on both sides appear to have very indefinite conceptions.

The second part of the monograph will consider the flexibility of the earth's crust as illustrated in the history of North America, the phenomena of rain and floods, the features of swamps and marshes, the buried forests of modern and ancient times; with other topics of similar import.

The third part will consider the various deposits of the Coal Measures, sandstones, shales, limestones and coals, the effort will be made to determine the sources and the mode of distribution of the inorganic materials; the origin of the coal and the causes of its variation in character, its mode of occurrence and the structure of coal beds.

The fourth part will sum up the results in an effort to show their bearing on the solution of the problem.

Problems in Petrology: J. P. Iddings, U. S. Geological Survey. (Introduced by President Keen.)

Front Range of the Rocky Mountains in Colorado: W. M. Davis, of Harvard College.

The Front Range of the Rocky Mountains in Colorado, now easily accessible by various railroad lines which enter and cross it from Denver and Colorado Springs, is an unusually fine example of a mountain highland, which in a former cycle of erosion was reduced to moderate relief, and which since elevation to its present altitude has been submaturely dissected by its streams. The highland is surmounted by numerous hills and mountains of from 500 to 2,500 feet relief, which represent the unconsumed residuals of the former cycle of erosion, and which, therefore, presumably consist of the most resistant rocks of the region. The uplift of the mountain belt to its present altitude was not perfectly uniform, but arched gently from the plains westward, thus the crest of the range seems to correspond to the crest of the arched uplift. A notable feature of the higher valley heads, among the surmounting mountains near the range crest, is the occurrence of numerous amphitheaters or cirques, and over deepened valley troughs, the work of glaciers which for a moderate time, as geological time is reckoned, replaced the water streams in the highest districts. The contrast between forms due to ordinary or normal erosional processes and to glacial erosion is thus displayed with unusual clearness.

Supposed Recent Subsidence of the Atlantic Coast: D. W. Johnson, of Harvard College. (Introduced by W. M. Morris.)

The author briefly reviewed the evidence in support of the generally accepted theory that the Atlantic Coast is subsiding at the rate of from one to two feet per century, and showed that the phenomena supposed to indicate subsidence might be produced by fluctuations in the height of ordinary high tides resulting from changes in the form of the shore line. A study of the Atlantic shore line indicates that conditions are there favorable to marked local changes in the height of the tides, independently of any general movement of the land. On the other hand, the structure of certain beaches along the coast affords very strong proof that there can have been no long-continued progressive subsidence of the coast

within the last few thousand years The theory of fluctuating tidal heights, and the theory of stability of the land mass were illustrated by selected examples of shore line phenomena

Relation of Isostasy to the Elevation of Mountains H F Reid, of Johns Hopkins University

The work of many investigators and more especially the recent work of Dr Hayford has shown that the earth is practically in isostatic equilibrium It follows that mountains can not be due to tangential compression or to the increase of matter in the mountains themselves, but must be due to forces of elevation resulting from the expansion of the material under the mountains Such vertical forces would in many cases cause normal faulting without tangential tension

The Transpiration of Air through a Partition of Water Elliptic Interference with Reflecting Gratings Carl Barus, of Brown University

A Phenomenon of Vision On Disruptive Discharges of Electricity through a Flame F. E Nipher, of Washington University

The High Voltage Corona in Air J B Whitehead, of Johns Hopkins University (Introduced by Professor Ames)

The author described the limitation to the long distance electrical transmission of power imposed by the insulating properties of the air, and a new method for determining accurately a voltage at which the air in the neighborhood of electric wires and cables will break down, and also gave the results of a series of experiments on the influence of the size of the wire, the stranding of the wire into a cable, the frequency, the pressure, the temperature and the moisture content of the air He also reviewed the bearing of present physical knowledge on the nature of the phenomena which are involved

The Nature and Causes of Embryonic Differentiation · E. G Conklin, of Princeton University

The Origin and Significance of the Primitive Nervous System G H Parker, of Harvard University (Introduced by Dr H H Donaldson.)

On Friday evening Professor Svante Auguste Arrhenius gave a lecture at the hall of the College of Physicians on "The Physical Conditions of the Planet Mars"

The lecture was followed by a reception.

The speaker called attention to the many similarities between Mars and the earth which have led some to think Mars is inhabited, but gave it as his opinion that later investigations are not favorable to this view

On Saturday morning at 9 30 the society held an executive session, at which candidates for membership were balloted for As a result the following were elected as members of the society George A Barton, A M , Ph D , Bryn Mawr, Pa , Bertram Borden Boltwood, Ph D , New Haven, Conn , Lewis Boss, A M , LL D , Albany, N Y , John Mason Clarke, Ph D , LL D , Albany, N Y , W M Late Coplin, M D , Philadelphia, John Dewey, Ph D , LL D , New York City, Leland Ossian Howard, Ph D , Washington, D C , Joseph P Iddings, Sc D (Yale, 1907), Chicago, Alba B Johnson, Rosemont, Pa , Arthur Amos Noyes, Ph D , Sc D , LL D , Boston, George Howard Parker, S D , Cambridge, Mass , A Lawrence Rotch, S B , A M (Hon Harvard), Boston, Leo S Rowe, Ph D , LL D , Philadelphia, William T Sedgwick, Ph D , Hon Sc D (Yale, 1909), Brookline, Mass , Augustus Trowbridge, Ph D (Berlin), Princeton, N J , Svante Auguste Arrhenius, Stockholm, Jean Baptiste Edouarde Bornet, Paris, Sir John Murray, K C B , F R S , LL D , Sc D , Edinburgh

At ten o'clock the morning session for the reading of papers opened, the following being presented

The Secretion of the Adrenal Glands during Emotional Excitement Walter B Cannon, of Harvard University

The adrenal glands and the sympathetic nervous system are intimately related The sympathetic system innervates the glands, and the glands in turn secrete a substance that affects bodily structures precisely as the sympathetic system affects them The sympathetic system is aroused to activity in states of emotional excitement Examination of the blood of excited animals reveals the presence of adrenal secretion which was not found in the blood before the excitement Possibly the adrenal secretion continues the excited state Possibly also the adrenal secretion caused by emotional disturbances has some of the effects produced by injection of the substance—such as glycosuria and atheroma of arteries Indeed, two of my students, Shohl and Wright, have recently shown that glycosuria can be produced in the cat by fright The suggestion, however, must be put to further experimental test.

On the Coagulation of Blood · W. H. Howell, Johns Hopkins University.

The theory of the coagulation of blood most commonly accepted at the present time holds that

three of the four necessary factors in the process are present in the circulating blood, but that this fourth which initiates the process in shed blood is furnished by the tissues outside the blood or by the disintegration of corpuscular elements in the blood itself. This fourth factor is an organic substance of the nature of a kinase which in conjunction with the calcium salts of the blood serves to activate the prothrombin, also present in the blood, to thrombin The thrombin then acts upon the fibrinogen and converts it to fibrin, which constitutes the essential phenomenon of clotting In opposition to this theory the author gave experimental evidence to show that in normal blood the fluidity is due to the constant presence of an antithrombin, and that in shed blood the tissue elements furnish a substance, thromboplastin, which neutralizes the antithrombin and thus allows clotting to take place In the vertebrates below the mammals, the thromboplastin is furnished by the cells of the outside tissues and without their cooperation clotting would not occur In the mammals thromboplastin is furnished by elements in the blood itself, the platelets, so that the blood may clot promptly without cooperation on the part of the outside tissues In human beings the condition known as hemophilia, in which there is delayed clotting and danger of fatal hemorrhage, the defect is due not to a lack of kinase in the tissues as a whole, the view usually taught at present, but to an excess of the antithrombin normally present in the blood.

Abnormal Forms of Life and their Application: ALEXIS CARREL, of the Rockefeller Institute.

The author stated the results of some remarkable experiments on the tenure of life in certain tissues when removed from the body and kept in cold storage

The Cyclic Changes in the Mammalian Ovary: LEO LOEB, of the St Louis Skin and Cancer Hospital.

In the mammalian ovary cyclic changes of a very far-reaching character take place They concern the follicles, corpora lutea and ova. There exists in the ovary a mechanism (in the corpus luteum) regulating those changes The corpus luteum prolongs the sexual cycle not by retarding the maturation of the follicles, but by preventing the rupture of the mature follicles My recent observations make it very probable that a partial parthenogenetic development of some ova accompany these cyclic changes in the follicles in a certain percentage of animals.

The Origin of the Porpoises of the Family Delphinidæ F W TRUE, of the U. S National Museum, Washington, D C.

Among the fossil remains of cetaceans obtained a short time since by the National Museum from the Miocene formation of Maryland, is a nearly complete skeleton of a porpoise, which, on examination, proves to be a delphinoid form, that is, a species which may be referred to the family Delphinidæ, but has tuberculate teeth This important specimen enables us to solve, in part, the hitherto unsolved problem of the origin of the typical porpoises of to-day. It now appears unquestionable that they were derived from forms having teeth with tuberculate or serrate crowns, rugose enamel, and anterior and posterior longitudinal ridges This form of teeth is indicated in the recent delphinoid genus *Stano,* in which the crowns have rugose enamel, and, as I have lately discovered, traces of anterior and posterior ridges.

Phylogenetic Association in Relation to the Emotions GEORGE CRILE, professor of clinical surgery, Western Reserve University, Cleveland, O

Helios and Saturn MORRIS JASTROW, Jr, of the University of Pennsylvania

On the Religion of the Sikhs MAURICE BLOOMFIELD, of Johns Hopkins University

An Ancient Protest Against the Curse on Eve: PAUL HAUPT, of Johns Hopkins University

In the biblical legend of the fall of man, which symbolizes the first connubial intercourse, the Lord pronounced a curse on Eve, saying, "I will greatly multiply thy sorrow and thy sighing In pain thou wilt bear children Nevertheless, thy desire shall be to thy husband, and he shall rule over thee" (Genesis 3·16)

We all know what the forbidden fruit in the Garden of Eden means He who eats of it loses his child like innocence, his eyes are opened; just as Adam and Eve perceived that they were naked. Not to know good and evil, that is, what is wholesome and injurious, means to be like a child.

We find this phrase in the eighteenth book of the Odyssey, verse 228 In the Bible it is used also of the second childhood Barzillai of Gilead answered David, when the king asked him to follow him to Jerusalem, "I am this day fourscore years old, and can no longer discern between good and evil"—that is, My intellect is impaired by old age, I have become again like a child.

An ancient protest against the curse on Eve in Genesis 3:16 is found in the story of Cain and Abel, where we read, "And unto thee shall be his

desire, and thou shalt rule over him" The story of the fall of man and the story of Cain and Abel were, it may be supposed, written in parallel columns.

The author of the ancient protest against the curse on Eve (who may have been a woman or a man under the influence of a woman, a species of genus *Homo* which is common) wrote this "suffragettie" gloss on the space between the two columns. Afterwards it crept into the text of the column containing the story of Cain and Abel The introductory verse connecting Cain and Abel and Adam and Eve is a subsequent addition The name Cain is explained there (Genesis 4 1) as being connected with the verb "canah," to produce When Eve bare Cain she said, "I have produced a man as well as the Lord Just as the Lord formed me from the rib He took from Adam, so I have produced now a new human being"

Some people think that when the Lord created Eve he took not only a rib from Adam, but his backbone Most of us have all our ribs If man eats his bread in the sweat of his face till he returneth unto the ground, and if woman bring forth children born to suffer, it is due to the forbidden fruit Schiller says the fabric of the world is held together by hunger and love

Theories of Totemism E WASHBURN HOPKINS, Yale University

He considered first the definition of totemism and the necessity of understanding the different religious systems which go by the name of totemism He showed that totemism must be disentangled from various accretions which have grown up with it before it is possible to discuss the essence of true totemism When this is done, much that has affected and even produced some of the theories falls away and at the end a comparatively simple belief is revealed which has been built up into various sorts of totemism, so that it is unnecessary to assume a graded and uniform growth in every kind of totemism Apparently later stages may come comparatively early The latest theory of Frazer was examined and compared with that of Lang and that of Wundt Besides this analysis and critique of older theories a new contribution to the theory of utility was made by the presentation for the first time of matter drawn from Sanskrit texts in which practically the same view is represented as that held by the ancient troglodytes Apart from some variations the most common direct cause of totemism is economic rather than religious and then blends with other religious factors, but is not so fundamentally, though there are forms of totemism which are based on religious conceptions and helping to its spiritualistic development

The New History J H ROBINSON, of Columbia University (Introduced by Professor Cheyney)

Eggettes a Conservation of Fuel R P FIELD, of Philadelphia

This paper dealt briefly with the general subject of the utilization of slack coal by manufacturing it into small briquettes, which are called eggettes, and showed that a binder which does not contain pitch or any kindred material is preferable for household use, and that by actual test the eggettes under consideration are cheaper than either anthracite or bituminous coal in the regular sizes, crushed coke, wood, oil or gas There was then given a brief description with lantern slides of the machinery used to manufacture these eggettes, and a few statistical tables

On Saturday afternoon besides the symposium and the papers in connection with it already mentioned a portrait of Thomas Hopkinson, first president of the American Philosophical Society, was presented by Leslie W Miller, principal of the School of Industrial Art, Philadelphia, also an obituary notice of Professor Jakob H van't Hoff, by Harry C Jones, of Johns Hopkins University

At the annual banquet on Saturday evening about one hundred members and guests were present, the president, Dr Keen, presiding Toasts were responded to as follows "The Memory of Franklin," by President Schurman, of Cornell, "Our Universities," by Count von Bernstorff and President Hadley, of Yale, "Our Sister Societies," by Professor W M Davis and Sir John Murray, "The American Philosophical Society," by Professor E C Pickering

Thus ended one of the most successful meetings in the history of the society

ARTHUR W GOODSPEED,
Secretary

SOCIETIES AND ACADEMIES

THE WASHINGTON ACADEMY OF SCIENCES

THE seventy second meeting of the Washington Academy of Sciences, a joint meeting with the Washington Society of Engineers, was held in the salon of the steamer *Southland* the evening of April 28, 1911, while en route from Washington to Norfolk, Va, President F W Clarke, of the academy, presided

A symposium on the Dismal Swamp had been

requested, and the committee on meetings decided to include an excursion to the swamp itself and to have the technical papers presented during the first stage of the trip This plan proved to be eminently practicable, and there is every reason why similar plans that bring people so pleasantly together should be more frequently adopted by scientific societies, for, after all, it is personal acquaintance and private discussion that count for most in such organizations

The first paper of the evening was by Mr E W Shaw, who described the "Geography and Geology of the Dismal Swamp" The various plateaus and old shorelines of eastern Virginia were pointed out and their formation explained The swamp is of recent origin, geologically speaking, and in general is well understood, though the existence of a lake near its center is a distinct puzzle, for the solution of which several more or less plausible theories have been advanced

The second speaker, Dr. C A Davis, discussed "Peat Deposits," a subject of which he is a, if not the, recognized master It was explained that the Dismal Swamp is a great coal field in the making, that it is covered with a layer of peat as much as fifteen feet thick in places, and that portions of this might even now be valuable as fuel

The next paper was by Mr. R Zon, whose subject was "The Forest Types in the Dismal Swamp" After a few introductory and general remarks on the relation of forests to climate and soil, the speaker described in greater detail the principal trees of the swamp, especially the cypress and the black gum.

Mr. F V Coville gave an interesting account of the "Plant Life in the Dismal Swamp," and made his many listeners anxious for the morrow when they were to see for themselves the yellow jasmine in bloom, the dense cane brakes and the many other wonders of plant life in their native jungle

Dr. F. W True told of the "Ground Animals of the Swamp" As these are not numerous, consisting mainly of musk and other rats, swamp rabbits and the like, the speaker so widened his talk as to include fishes, of which there are many varieties, bears, of which there is an abundance; and snakes, of which there is said to be a superabundance.

The last speaker of the evening, Dr. C. Hart Merriam, had for his subject, "The Birds of the Swamp." But as snake stories seemed to take unusually well, and as birds are only feathered reptiles, Dr Merriam began his talk with an account of certain varieties of snakes that abound in the Dismal Swamp—rattlesnakes, copperheads, water moccasins, king snakes, black snakes, water snakes and just plain snakes Having disposed of the snakes, the speaker next described the large variety of birds that have been found in the swamp, and so painted their beauty that, for the time being, even the snakes were forgotten

From Norfolk, Va, the entire party of about 135 was taken into the swamp and even to Lake Drummond, as the guests of and on boats especially provided by the Lake Drummond Canal and Water Company

Many returned to Norfolk the same day, while others camped out near the banks of the lake and returned to Norfolk the following day.

In every particular the excursion was a delightful one, due to the unusualness and the beauty of the place visited, to the exceptional courtesies, including even a complimentary luncheon, of the Lake Drummond Canal and Water Company, and to the untiring supervision of the genial David T. Day, who not only planned the details of the trip but also secured their execution without a single hitch

W J HUMPHREYS,
Secretary

THE PHILOSOPHICAL SOCIETY OF WASHINGTON

THE 695th meeting was held on May 6, 1911, Vice president Fischer in the chair Two papers were read:

Simple Ammonia Apparatus for Temperatures to Minus 70° Centigrade: PROFESSOR C F. MARVIN, of the U S Weather Bureau

The apparatus described and exhibited by the speaker was designed for general laboratory work wherever a liquid bath maintained at the desired low temperature could be made to answer the purpose

The apparatus consisted of a large cylindrical copper tank about 11 inches in diameter and 18 inches high This was jacketed all around, except on top, with thick wooden walls and an interlining of animal hair felt. Inside the copper tank was placed a ring-shaped iron ammonia flask made up of two short sections of standard iron pipe having annular heads at each end. The flask measures about 10 inches in diameter outside by 9 inches high, and 7 inches across the ring inside The flask is supported centrally on three lugs inside the tank, and is provided with a suitable outlet pipe and valve at the top.

In use the tank is filled with alcohol or non-freezing liquid (about 3½ gallons), and the flask charged (two thirds or more) with liquid ammonia (5 to 6 pounds). To lower the temperature, gaseous ammonia is allowed simply to escape slowly from the flask The fumes may be led into a vessel of water with the formation of aqueous ammonia, or allowed to escape entirely A strong circulation of the liquid of the bath is maintained by means of an efficient form of motor driven stirrer

The temperature can be lowered to —25° to —30° C., by the spontaneous evaporation and escape of the ammonia For still lower temperatures it is necessary to use a suction pump to increase the evaporation by reduction of pressure A simple hand pump was described for this purpose with the novel feature that the outlet valve opened directly into a water jacket space supplied with running water Moreover, the valve itself had a small hole directly through it, so that water constantly leaked into the pump chamber and these absorbed large volumes of gaseous ammonia. When in operation, the object of working the piston of the pump up and down is quite as much to expel the water leaking into the pump chamber as to take off the gas, large quantities of which are absorbed by the fresh water entering the pump after each stroke

An apparatus of this character has been used for many years at the Weather Bureau in the comparison of thermometers and other low temperature work, and was first described in Annual Report of the Chief Signal Officer, 1891–92, p. 355. The bath can readily be lowered to —40° C, and thermometer comparisons carried on over a period of four or five hours with an expenditure of not over five or six pounds of ammonia, which costs about $1 50 Experience demonstrates that in a small apparatus of the kind described, it is much more convenient and economical to let the ammonia escape after evaporation than to try to recondense it back to the liquid state. It proves to be quite practicable to carry the temperature down to —70° C, at which a number of thermometer comparisons have already been made

Recent Gravity Work by the Coast and Geodetic Survey: WM. BOWIE, of the Coast and Geodetic Survey.

This paper gave an account of the gravity work done by the Coast and Geodetic Survey during the past few years In 1891 the survey began the use of two sets of half second pendulums which proved efficient and accurate in this relative determination of gravitation, using the gravity pier at the Coast and Geodetic Survey Office as the base station As first constructed the knife edges were fastened to the head of the pendulum with the supporting planes on the pendulum case Several years later this method was reversed, the planes being placed in the pendulum head and the knife edges on the case This gave a more invariable length of the pendulum, as the effect of any wear on the planes would be negligible

The different apparatus used in making the observations were illustrated by lantern slides Previous to 1909 the relative value of the intensity of gravity had been determined at forty seven stations in the United States In that year a campaign of gravity work was begun and is still in progress It will probably close at the end of the present year During the past two and one half years fifty six stations have been established By the end of this year the intensity of gravity will have been determined at about twenty additional stations This will make a total in the United States of about one hundred and twenty stations

The apparatus and methods are sensibly the same as those used in previous work except that an interferometer was used for determining the flexure of the pendulum case due to the horizontal force applied by the swinging pendulum This took the place of the static method The interferometer had never been used previously in any country for determining flexure on the field

In 1909 J F Hayford, the inspector of geodetic work in the Coast and Geodetic Survey, made an investigation of the effect of topography and isostatic compensation on the intensity of gravity, using fifty six stations in the United States He read a paper showing his results at the meeting of the International Geodetic Association at Cambridge and London in that year By the application of the theory of isostasy the large anomalies between the theoretical and actual value of gravitation by the Bouguer and free air reductions were greatly reduced. The mean anomalies without regard to sign for the fifty six stations were 064, 027 and 015 dyne for the Bouguer, free air and Hayford methods, respectively

An analysis of the anomalies by the new method showed that there is only a slight, if any, connection between the size and sign of the anomaly and the character of the topography surrounding the station

The results from this investigation confirm the conclusions arrived at by Mr Hayford in his two investigations of the figure of the earth and isostasy He and the speaker have nearly completed an enlargement of this investigation, using eighty-nine stations It is expected that the results of this investigation will be published by the survey during the coming year This investigation will verify the conclusions arrived at from the preliminary one The work done by the Coast and Geodetic Survey proves that a close approximation to the condition of complete isostasy exists

(The abstracts of the above papers are by their authors)

R L Faris,
Secretary

THE AMERICAN CHEMICAL SOCIETY
NEW YORK SECTION

The eighth regular meeting of the session of 1910–11 was held at Rumford Hall on May 5 Professor Chas Baskerville in the chair

Resolutions were offered on the death of Mr Bernard G Amend

The day of the meeting marked the centenary of the birth of John W Draper and a committee was appointed to consider some fitting memorial celebration

The following papers were presented

"A Tetracetyl Glucosamine Glucoside," M L Hamlin

"Studies on Amylase III Experiments on the Preparation and Properties of Pancreatic Amylase," H C Sherman and M D Schlesinger

"The Lactic Acid Ester of Santalol and other Santalol Compounds," Frederick S Mason

"Electric Tube Furnaces with Calorite Resistors for Laboratory Use," S A Tucker

"A New Rapid Method for the Determination of Manganese in Iron and Steel," F. J Metzger and L E Marrs

"The Oxidation of Ferrous Salts," Chas Baskerville and Reston Stevenson

"Contributions to the Chemistry of Anesthetics III Nitrous Oxide," Chas Baskerville and Reston Stevenson

C M Joyce,
Secretary

THE TORREY BOTANICAL CLUB

The meeting of March 29, 1911, was held at the museum building of the New York Botanical Garden at 3 30 P M Vice-president Barnhart occupied the chair. Thirteen persons were present

The following communication from Miss Caroline C Haynes was then read

Sixteen East Thirty-sixth Street,
New York City.

Mr Bernard O Dodge,
Secretary and Treasurer,
Torrey Botanical Club, Columbia University

Dear Sir It is desired by a number of the members of the club and by others interested, to establish a fund in memory of the late Professor Lucien Marcus Underwood, the income of which may be used to aid in the illustration of the Club's publications It is hoped that this fund may reach at least $5,000.

I ask that you obtain from the club its consent to administer such a fund, and enclose my check for $100, as an initial subscription drawn to the order of the Torrey Botanical Club.

Sincerely yours,
(Signed) (Miss) Caroline C Haynes
February 15, 1911

Dr M A Howe made a motion that the club establish a Lucien Marcus Underwood fund, the income of which shall be used in illustrating the publications of the club, and that the secretary be instructed to convey to Miss Haynes the hearty and appreciative thanks of the club for her generous initial subscription The motion was unanimously adopted

The resignations of Elizabeth Billings, Alice Knox, W L Sherwood and Rev L T Chamberlain were read and accepted

Dr H H Rusby reported having received several acceptances to his invitations to become sustaining members of the club

First on the announced scientific program was a paper on "Virginia Fungi" by Mr. B O Dodge After reviewing the literature relating to Virginia fungi the speaker gave a report on the fungi collected on the estate of Mr. Graham F Blandy at White Post, Clark County, Va., last September.

The second number on the program was on "A Little known Mangrove from Panama," by Dr. M. A. Howe The mangrove in question, *Pelliciera Rhizophorae*, a member of the Tea or Camellia Family, was found in association with *Rhizophora*, *Avicennia*, etc, near the Pacific terminus of the Panama Canal Specimens and photographs were exhibited A description and discussion of this mangrove will appear in the April number of the *Journal of the New York Botanical Garden.*

B O. Dodge,
Secretary

SCIENCE

FRIDAY, JUNE 16, 1911

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MSS. intended for publication and books, etc., intended for review should be sent to the Editor of SCIENCE, Garrison-on-Hudson, N. Y.

THE SPIRIT OF ALCHEMY IN MODERN INDUSTRY

NEVER in the history of the world has there been such a time of intense human activity as the present never a time of such gigantic undertakings, such marvelous achievements Notwithstanding, the curve of progress is still an ascending one, although for some nations it has run parallel to its axis for many centuries, yet nowhere on the earth is there not at present a marked break in the line which for so long has represented a monotonous level in human affairs

While there has been remarkable progress in ethics, culture and the fine arts, this world movement in human endeavor is epitomized in the expression "modern industry" Of the many factors which have entered into the advance in industry as a whole, possibly the most important is found in the manufacture and use of power Where once we measured results by what a man could do, or later what a horse could do, now we measure the power at our command by thousands of kilowatts We have had an age of steam, and we are passing through an age of electricity, and what next? Many think it will be an age of unprecedented chemical development We have reason to be well satisfied with our present achievements, we do things so much more quickly and on so much larger a scale than our ancestors did But at this enviable rate we can see the end of our resources—coal, timber, iron ore, are already measured in years We must improve our present methods We must inaugurate along every line of great endeavor a systematic search for new

truths, new light into the secrets of nature in order that we may live and work more efficiently

It may seem a long step from a consideration of human dynamics at the intensity of the present, to the work of the alchemists of centuries ago, with all their magic and mysticism, their solitary lives and cherished secrets But in reality there is something in common between these ancient investigators and the leaders in modern industry, and in looking ahead as to how we can best utilize the possibilities of the future we may learn something by considering the mistakes of the past

The captains of industry and their army of co-workers are still alchemists at heart, they still strive to transmute the base materials of the earth into gold But where the alchemist was satisfied only with seeing the noble metal glittering in his alembic, the modern business man is content in obtaining from his still a treasury certificate It requires no magic philosopher's stone to effect a transmutation of paper into gold when once the former bears the proper inscription Wherein have modern methods of alchemy changed from those of that eminent scholar who bore the name Phillipus Aureolus Theophrastus Bombastus von Hohenheim, and who lived and worked in the twelfth century and an account of whose checkered career has been handed down to us?

The spirit of alchemy is well represented in the word itself. It is an Arabic prefix, and the old Latin word for Egypt, meaning the dark, secret or hidden It was the black art of the ancients Another name sometimes used was "hermetic art," meaning also closed or sealed from view. The goal of those men from the gray of antiquity to the monks of the middle ages was the discovery of a way to make gold and silver from the metals already known, such as mercury and copper, tin and iron We can see as we look back over their labors how now and again they received just the encouragement necessary to keep alive the embers of hope which glowed in each one's primitive laboratory By melting the base metal copper with an earth which we now know carried arsenic, a silver white metal was formed, how easy to believe that this was an impure silver which needed but refining to be the longed-for result When iron was left in a water solution of blue stone it disappeared and copper was found in its place Surely this was a transmutation of iron and copper Why not under proper conditions a further change of copper into gold?

But very many patient and able men devoted their lives to this fruitless search without material progress being made The alchemists of Arabia and early Germany were little wiser than their predecessors of Egypt many centuries before them. The explanation of this lack of progress is to be seen in the profound secrecy which was at all times maintained When some enterprising worthy did take it upon himself to transcribe for future generations his knowledge of the mystic art, his sentences were so ambiguous, and his diction so involved, as to make the whole entirely meaningless Mysterious symbols were employed to render imitation the more difficult

There was, therefore, no accumulation of knowledge or experience, and each succeeding investigator continued to grope in the darkness which had ever enveloped his calling, without deriving any benefit from the labor of either his predecessors or his contemporaries The great and insurmountable obstacle to progress was nothing more than the jealous secrecy engendered by selfish competition. Both confidence and cooperation were entirely wanting.

Each one feared that his neighbor might profit by his experience were it to become known, never realizing that he must in the end get much more in return than he gave. There was but one of him, while there were many of his neighbors.

But in the thirteenth century there came a change. One Roger Bacon, who from his rare accomplishments and erudition was called Doctor Mirabilis, and who firmly believed in the existence of the philosopher's stone, was being tried at Oxford for sorcery. To disprove the charges against himself, he wrote a celebrated treatise with a long Latin name, in which he showed that phenomena which had been attributed to supernatural agencies were in fact due to common and natural causes. He pointed out further in his brief, a possible distinction between what he called theoretical alchemy, or work which could advance the knowledge of natural phenomena, and practical alchemy, or the striving after immediately usable information. He is to be regarded as the intellectual originator of experimental research, and by his generous treatment of the knowledge gained, gave to the movement the impetus for which it had so long waited. The limitations of this paper preclude my following in any detail the development of chemistry through the succeeding centuries, but it can be easily shown that just as knowledge was sought after for its own sake, and in proportion as there was free and honest intercourse between the investigators of the time, just so rapidly was real progress made.

The course of human events has been compared to a pendulum. We tend to swing to extremes, to go too far first in one direction, and then in the other, when real progress lies in the middle. The period of alchemy represents the pursuit of science for selfish and sordid ends, its sole object was that of making gold. The pendulum was at one extreme of its path. But at that time, as at this, the making of gold by whatever means did not in itself bring happiness or contentment, or even success. With the appearance of men who took an absorbing interest in the study of natural phenomena, for the purpose of gaining a deeper insight into the world around them, when investigations were undertaken from a desire to know, and to acquire knowledge which could become the property of the world at large, the pendulum began to move back.

For years the efforts of investigating minds were devoted to the explanation of the phenomena of nature, to the discovery of new laws and principles, to the accumulation and organization of facts, into what is called a science—to a real search for truth. This resulted in a general uplift of humanity, an advance in civilization, which can not be described or measured in words. It was a time when the human mind was struggling to determine realities in the midst of tradition and superstition, to realize that nature is always complex but never mysterious, that dependence should be placed in proven facts rather than the vagaries of priests and philosophers. Man became intellectually free.

But for many years after the broad generalizations upon which modern chemistry is founded were well established, industry did not profit much by scientific work. One hundred years ago the men who smelted the iron and copper, the lead and zinc, knew little of the principles underlying their practise. Leather was tanned, woolens and silks were dyed, porcelains and glass were made, without the aid of those who alone knew the chemistry involved. These were times when the advance in chemical knowledge was far ahead of the industries on the success of which

our material comforts depend, and which then stood in such need of help

A rational attempt to apply chemical knowledge and methods to the industries commenced about 1850, and is in reality contemporaneous with the founding of the Institute of Technology which we to-day celebrate It was in 1856 that Perkins made the first synthesis of a coal-tar color, and founded the industry which has become the most remarkable example of applied chemistry that we have In 1855 Bessemer introduced his revolutionary process for making steel, made possible by the clear understanding of the nature of steel through improved analytical processes With the founding of the Institute of Technology and other similar institutions, which not only did its part in advancing science, but taught its students how to apply this science to the problems of the day, our industrial progress has gone forward with leaps and bounds

I would point out in passing that a great contribution in the aid of civilization is not necessarily made by the simple discovery of a scientific fact Although, for example, the reactions underlying the ammonia-soda process were well known for many years, this knowledge did not benefit the world until the genius of Solvay made through it pure and cheap soda available Cavendish long ago discovered that an electric arc produced nitric acid from the air, the world waited until a few years ago in order to profit by this knowledge, when the researches of Birkeland and Eyde made of the idea an industrial process It was for this ability to apply scientific facts to the necessities of the times, that the world was looking at the time of the founding of the Institute of Technology. Much pure science we had, but it was as yet largely "uncontaminated by the worship of usefulness," if I may quote a contemporary. It was to just the kind of men which the Institute of Technology turned out—men who could appreciate the beauties of pure science, and at the same time had the ability to apply it, that our marvelous advance in material prosperity was due.

But to-day there can be seen evidences of a swing of the pendulum past the center, and again to approach an undesirable extreme Research has become a word to conjure with Private bequests for institutions of research in almost every field of science are made in units of millions of dollars The most significant movement, however, is the very general establishment of laboratories for research, and especially chemical research, by great industrial organizations This movement is but in its infancy, and it is here that a return of the old spirit of alchemy is to be feared It has its foundation in the impatience of the more enterprising firms to wait for scientific facts and principles to be discovered by others, hence their willingness to appropriate often very large sums of money and to actively enter the field of what is called research in applied chemistry

From what has already been said, there may appear to be a paradox in the expression "research in applied chemistry" How can the element of research enter into the work of applying to definite ends the facts already established as true by others? Is there a difference between research in so-called pure chemistry, and research in what, for want of a better name, we will call applied chemistry. Possibly I can make the distinction clear by a rough analogy. The development of research in a science may be compared to the exploration of a new country. New roads are to be laid out, tunnels bored and bridges built, in other words, new problems solved. This may be done in two ways First, constructive work may be

undertaken wherever an interesting problem presents itself, without regard to whether there is a demand for such structure or not It is built because of the interest of the builder in solving this particular difficulty, and the pleasure he takes in it, knowing also that some time it will be utilized As a rule he is under no great pressure to get the structure completed This may represent the method of pure chemistry, and the great advance in scientific knowledge of the past was made by boring just such tunnels and building just such bridges The industries have used these structures when they could, or when some second builder could adapt them to use Research in applied chemistry differs from that just described only in this—I should say, it *needs* differ only in this—that when a problem is to be solved, a bridge to be built, the work is undertaken at a point where there is a demand for its use, where people are waiting to cross over so soon as it is finished The method of building is no different, the difficulties no less The fact that the bridge is to be used makes the work of building no less dignified, nor is it possessed of less pleasure In both cases the builder profits by all that has been done before, and contributes his bridge and the new materials of construction he may have found, to those who may come after him To cite an example from experience, suppose I determine the electrical conductivity of metallic oxides at high temperature with great accuracy, and publish the results without reference to any particular application of the data This is pure science But suppose I am trying to perfect an electrical heating unit for high temperatures, and in insulating my resister I do this identical piece of work, namely, measure with great accuracy the electrical conductivity of metallic oxides at high temperature, and again publish the results This is applied science The work need not differ in the least degree It can be as accurately done and the conclusions as scientifically drawn The mere fact that the data will be used for some practical end need not make the work any less purely scientific

Why then has research in pure chemistry commanded more respect than research in applied chemistry? Why did an eminent writer a few months ago lament the fact that there is not more research "uncontaminated with the worship of usefulness"? Why does usefulness contaminate? I think it lies in this the investigator of pure science works in the broad daylight, throws his product open for inspection, and invites all to come and use it when they can In applied chemical research the spirit of alchemy tends to creep in The builder keeps his materials of construction, and his designs, a secret, and so boards up his bridge that those who cross over it can not see how it was built, nor profit by his experience The moment a thing becomes useful we become jealous of its possession, we become narrow in our horizon, we sell our scientific birthright for a mess of potage, we become alchemists

There is a heavy moral obligation on the part of large industrial organizations having fully equipped research laboratories, to contribute their share to the advance of the world's knowledge They have well-stocked libraries, and are provided with all the current periodicals, they profit by all the scientific work which has been done and is being done This is as it should be, and such firms are to be commended for their progressiveness But is this not a reason why such laboratories should do their part in adding to the sum of available knowledge? There is in every laboratory much work which could be published and yet conserve the interests of the corpora-

tion First there are the results which may not have proved valuable to the laboratory in which they were obtained, but which would be of immense value to some one else working in an entirely different field Second, there are those results of value to the laboratory possessing them, but which could be published in an unapplied or "pure" form and which would make an important contribution to science and at the same time the publication would work no injury to the company or corporation most interested And finally there are those results of operations and processes, machines and apparatus, which, if the truth were known, are possessed by a large number of concerns, but are held as valuable secrets by each Every one would profit and no one be the loser by so far-sighted and generous a policy Germany is very justly held up before us as a shining example of marvelous industrial progress and prosperity A very great deal of the credit for her present position is due to her splendid educational system But no small factor in her national progress is the helpful attitude which her industrial organizations take toward the publication of scientific data The individual does not suffer, while Germany both from a purely scientific and an industrial standpoint is rapidly advanced But too often with us the president and his board of directors are alchemists; they fail to see why, if they pay the salaries of their research men, they should give to the public, or their competitors, any part of their results They exclaim "what has posterity done for us?" They would have their laboratories remain the secret chambers of the alchemists, and continue to improve their methods of changing baser materials into gold without regard to the obligations which they owe to their fellows.

It requires no extensive mathematical calculation to prove that the manufacturers themselves would be the ones to profit by such a liberal treatment of the results of scientific work Of one hundred manufacturing concerns each one would give but one per cent of the whole contribution, while he would receive the remaining ninety-nine per cent He could not in the long run be the loser But of vastly more importance, he would feel and know that his organization was taking part in a world movement toward that increase of human knowledge upon which all real progress depends Why become selfish and sordid so soon as one's scientific work becomes of immediate value to one's fellows? The greater sense of satisfaction, the greater success even of an industrial organization, lies in a fuller, freer, more generous publicity of the scientific results of their laboratories Would that each such industry might benefit by the experience of Solomon, King of Israel, who, when asked, "What shall I give unto thee?" replied, "Give me knowledge and wisdom," and he was answered, "Wisdom and knowledge are granted unto thee, and I will give thee riches and wealth and honor"

WM H WALKER
MASSACHUSETTS INSTITUTE
OF TECHNOLOGY

APPROPRIATIONS FOR THE DEPARTMENT OF AGRICULTURE[1]

THE growth of the National Department of Agriculture during the past ten years has far exceeded that of all of its preceding history This was pointed out by Hon Charles F Scott, chairman of the House Committee on Agriculture, in submitting the new agricultural appropriation bill last winter Its growth as marked by a decade has been phenomenal, viewed either from the standpoint of its scope and authority, its material resources, or its personnel.

[1] From the *Experiment Station Record*, April, 1911

As a full-fledged department with a cabinet minister at its head, the department dates only from 1889. But if we go back to 1839, when $1,000 was appropriated for "agricultural statistics," and include every dollar appropriated out of the treasury of the United States for agricultural purposes down to and including the year 1900, the total sum is, as Mr Scott pointed out, only $45,102,616, while the aggregate of all the money appropriated from the end of 1900 to the end of the current fiscal year reaches a sum nearly double this, or $90,012,058. For the fiscal year 1901 the appropriation for maintenance was $3,304,265.97. This year the department has at its disposal $15,470,634.16. "Ten years ago the total number of persons employed in the department was 3,388, this year if all the rolls were called an army of 12,480 men and women would respond."

Under the bill which the committee submitted, and which after considerable discussion and amendment received the signature of President Taft March 4, provision is made for an even greater development during the ensuing year. The aggregate amount carried by the act is $16,900,016, which by far exceeds that granted in any previous measure, and is $887,050 in excess of the estimate submitted by the department.

There is an apparent increase over the appropriation act for 1911 of $3,412,380, but of this $720,000 is only nominal, since it merely replaces what has hitherto been provided automatically as a permanent appropriation to the state experiment stations under the Adams Act. It will be recalled that by the terms of that act as subsequently construed in the appropriation act for 1907, definite appropriations were made only until July 1, 1911. The action taken by congress now provides for the continuance of the Adams Fund on the same basis as the Hatch Fund, requiring the amounts to be appropriated annually in the agricultural bill. With due allowance for this item, however, there is still an actual enlargement of the appropriations of every bureau, and a net increase of fully 20 per cent. for the department as a whole.

In general the increased appropriations are for the purpose of extending and developing lines of work already under way rather than the undertaking of new projects, and some of the principal increases are for what may be termed the administrative activities of the department. One of the largest new items is an appropriation of $1,000,000 for fighting and preventing forest fires in the national forests in cases of extraordinary emergency. This appropriation is in addition to the regular appropriation of $150,000 for fire fighting under ordinary conditions, and supplements deficiency appropriations of over $900,000 incurred as a result of the disastrous fires of last summer.

The federal meat inspection, which has been enforced by the department from a permanent annual appropriation of $3,000,000, receives an indirect increase of $155,000 through the transfer of its clerical force to the statutory roll of the Bureau of Animal Industry. The Bureau of Chemistry receives $60,000 additional for the enforcement of the Food and Drugs Act, and the Weather Bureau $75,490 additional for its weather service. Provision is also made by an appropriation of $87,000 for the enforcement of the Insecticide Act, which became effective January 1, 1911, and for which a deficiency appropriation of $35,000 had been allowed for expenses to July 1.

A number of propositions involving general legislation were considered in connection with the bill, but as finally enacted the law remains substantially a routine measure. The secretary was again authorized to continue investigations on the cost of food supplies at the farm and to the consumer, and a special appropriation of $5,000 was added for a study of chestnut bark disease.

Comparison of the allotments to the various bureaus in this act and those preceding it is rendered difficult because their clerical employees will, in accordance with a clause inserted in the act of 1911, be transferred on July 1 from the various lump-fund appropriations on which a portion of them had been carried to the roll of positions specifically provided for. These transfers in certain cases—

as, for example, in this office and the Bureau of Statistics—involve but a few employees, but in the case of the Forest Service, where 1,894 forest rangers and similar employees are to be transferred, they occasion an apparent increase in the appropriations for statutory salaries from $60,200 for the current year to $2,318,680, with a corresponding deduction from lump-fund appropriations The lump-fund appropriations, therefore, for a particular purpose, such as biological investigations or soil-survey work, no longer indicate so completely as they did previously the entire expenditures for these objects Comparison is still possible, however, as regards the aggregate appropriations of the bureaus

The Weather Bureau receives a total of $1,600,250 Of this amount, $15,000 is for the restoration of the Weather Bureau station at Key West, Florida, wrecked by hurricanes in October, 1910 The allotment for maintenance of the bureau printing-office was reduced to $18,000 by reason of the recent transfer of a portion of the equipment to the Government Printing Office For investigation of climatology and evaporation $120,000 was provided, as at present

The appropriations to the Bureau of Animal Industry aggregate $1,654,750 Aside from the increase due to the transfers from the meat-inspection act, previously referred to, the chief additions are those of $7,120 for the tick-eradication work, making that appropriation $250,000, an increase of $7,000 for the work of the Dairy Division, making its total $150,000, and of $7,640 for the Animal Husbandry Division, or $47,480 for that work Under a new clause inserted in the act, the Secretary of Agriculture is authorized to permit, under certain conditions, the admission of tick-infested cattle from Mexico into those portions of Texas below the quarantine line.

New appropriations were made of $65,000 for the purchase of land for quarantine stations near Baltimore, Md, and Boston, Mass; $10,000 for equipping the 475-acre experiment farm which has recently been acquired at Beltsville, Md., and $16,500 for constructing buildings at this farm and that at Bethesda, Md It is expected to utilize the Beltsville farm for the experimental work of the Animal Husbandry and Dairy Divisions, and to reserve that at Bethesda for pathological investigations

One of the largest increases in the bill was accorded to the Bureau of Plant Industry, which will receive $303,480 additional, making its total $2,061,686 The lump-fund appropriation for general expenses is $1,441,586, which is divided among thirty projects Some of the largest of these are $350,000 for the boll-weevil campaign (a net increase of $106,945), methods of crop production in the semi-arid or dry-land sections, and for the utilization of lands reclaimed under the Reclamation Act, for which a net increase of $38,270 and a total of $143,060 is granted, $142,920 for the farm management studies, of which $4,000 is to be used in agricultural reconnoissance work in Alaska, studies of the production, handling, grading, and transportation of grains, for which $135,005 is available, an increase of $24,500, and the studies of fruit improvement and the methods of growing, packing and marketing fruits, which will have $87,735 The investigations of the cotton industry were extended to include the ginning and wrapping of cotton

For the purchase and distribution of valuable seeds and plants the allotment made was $289,680 This is an apparent decrease of $19,910, but it is accounted for in part by transfers of clerical employees to the statutory roll of the bureau, and in part by the segregation as a distinct project of $20,000, which was formerly supported from this fund The two items comprising this appropriation are the congressional seed distribution, which is continued on the usual basis, with $237,160, and the allotment for the introduction of seeds and plants from foreign countries, which is increased to $52,520

The appropriations to the Forest Service reached a total of $5,533,100, in addition to the various emergency appropriations to which reference has been made. This, as usual, represents the largest appropriation to any one bureau, and is also the largest increase

over the previous year, the total for 1911 having been $5,008,100 The policy of definite allotments to each of the 161 national forests for maintenance was continued The Nebraska National Forest was authorized to furnish young trees free of charge to settlers in the surrounding region

The sum of $150,000 was granted for fighting forest fires and for other unforeseen emergencies, of which $70,000 is immediately available The allotment for permanent improvements on the national forests was increased from $275,000 to $500,000 Provision was made for the refunding to claimants of moneys erroneously collected in the administration of the national forests, and for the granting of easements under certain conditions for rights of way across the public lands, national forests, and reservations, for the transmission of electrical power and for telephone and telegraph purposes

Liberal provision for the development of investigational work was also made, $177,040 being granted for investigations of methods for wood distillation and preservation and the economic use of forest products, including the testing of woods for paper-making, together with $18,420 for investigations of range conditions within National Forests and range improvement, $251,168 for silvicultural and dendrological experiments, and $33,760 for miscellaneous forest investigations and the preparation and dissemination of results

The appropriation of the Bureau of Soils was increased to $262,060 No appropriation was made for soil erosion investigations, for which $5,000 has been allotted annually for many years The soil survey work received $145,000, a net increase of $13,040, with a provision added limiting to 10 per cent the expenditures in any state

The bureau was authorized to undertake a new line of work by the appropriation of $12,500 "for exploration and investigation within the United States to determine a possible source of supply of potash, nitrates and other natural fertilizers," $2,500 being made immediately available It is expected that particular attention will be devoted to possible sources of potash in view of the present situation as regards the German potash supply. The work will also be supplemented by researches to be conducted by the Geological Survey, which received authority in the sundry civil appropriation act to expend $40,000 "for chemical and physical researches relating to the geology of the United States, including researches with a view of determining geological conditions favorable to the presence of potash salts" According to a recent announcement from the survey, the expenditure of half this appropriation for the potash exploration is contemplated

The Bureau of Entomology receives an aggregate of $601,920 This is an increase of $69,740, mainly for the extension of work to the alfalfa weevil and for enlarging the investigations on insects affecting rice and sugar-cane, for demonstration work against forest insects, and for additional studies in bee culture The largest single allotment is for the continuation of the campaign against the gipsy and brown-tail moths, for which the appropriation is $284,840

The large proportionate increase of $52,780 was accorded the Bureau of Biological Survey, making its total $139,700. All the various lines of work were continued on a more comprehensive basis, and new items were included of $2,500 for the purchase, capture, and transportation of game for national reservations, and of $20,000 for the feeding, protecting and removal of elk at Jackson's Hole, Wyo, and vicinity The latter appropriation is made immediately available and remains available until expended.

The activities of the Office of Public Roads have been rapidly increasing in recent years, and to keep pace with the growing demands the appropriation was increased from $114,240 to $160,720 A new line of work authorized is the conducting of field experiments in road construction and maintenance, for which $10,000 is granted

The total appropriation of the Office of Experiment Stations is $1,864,000, of which $1,440,000 is allotted to the state experiment stations under the Hatch and Adams Acts.

Of the remainder, $56,500 is for statutory salaries and $37,500, a net increase of $5,000, is for general expenses. The allotment of $10,000 for the agricultural education service was continued as at present.

The nutrition investigations received an increase of $5,000, making $15,000 available for this purpose. This increase will enable further extension of these investigations and the preparation of popular bulletins setting forth plans for the more economical and effective utilization of agricultural products as human food, for which data a strong demand has been in evidence.

An estimate of $20,000, submitted for the preparation, publication and dissemination of original technical reports of the scientific investigations of the experiment stations by the Secretary of Agriculture in cooperation with the Association of American Agricultural Colleges and Experiment Stations, was favorably recommended by both the house and senate committees, but failed of passage.

The Alaska, Hawaii and Porto Rico experiment stations were given $30,000 each, an increase of $2,000 in each case to equalize their funds with those received by the state stations from federal funds, and the Guam Station was continued at $15,000. The clause requiring the expenditure of $5,000 by the Porto Rico Station for coffee experiments was omitted, thereby restoring the coffee work to the same basis on which it has been conducted for many years previous to the passage of the act for 1911.

The irrigation and drainage investigations each received $100,000, a net increase of $32,820 and $25,980, respectively. These increases will enable the extension of these lines of work, especially in the rendering of assistance to settlers in newly irrigated regions, and in formulating plans for the reclamation of swamp lands. The provision requiring a special report of the aggregate expenses in the drainage investigations to date and the areas in the several states and territories which have been investigated was continued.

The work of the remaining bureaus was provided for along substantially the present lines. Including the increase previously noted for the enforcement of the Food and Drugs Act, the Bureau of Chemistry will receive $68,080 more than at present, and a total of $963,780. The Bureau of Statistics is given $231,020, the Library, $40,500, the Office of the Secretary, $276,450, the Division of Accounts, $97,520, the Division of Publications, $209,960, and the fund for contingent expenses, $110,000. These all contain small increases, occasioned in general by the growth of the department.

In addition to the sums carried in the appropriation act itself, there should also be considered the appropriation of $470,000 for the department printing and binding, which appears in the appropriation act for sundry civil expenses. This represents a nominal increase of $10,000, but $22,000 more than at present is assigned to the Weather Bureau by reason of the transfer of a portion of its branch printing office, making a virtual decrease of $12,000 for the remainder of the department. There is also to be added the permanent appropriation of $3,000,000 for the meat-inspection work. Deficiency appropriations were granted, as well, of $923,192.90 for the fighting of forest fires in 1910, the relief of employees of the department killed or injured in that campaign, and for horses and equipment destroyed during it, and $35,000 for the enforcement of the Insecticide Act during 1911.

Additional funds which will be administered by the department are provided in the measure enacted at the recent session of congress for the protection of the watersheds of navigable streams, and popularly known as the "Appalachian Forest Reserve" Act. Under this act the secretary of agriculture may expend $200,000, in cooperation with states requesting it, in the protection from fire of the forested watersheds of navigable streams, irrespective of ownership. He is further authorized to purchase, following a favorable report by the Geological Survey and the approval of a National Forest Reservation Commission, of which he is *ex-officio* a member, lands located at the headwaters of navigable streams,

and to administer these lands as permanent national forests An appropriation of $2,000,000 is made annually until July 1, 1915, for the examination and acquisition of these lands, together with $25,000 additional annually for the expenses of the commission

Eliminating the deficiency appropriations and that for the Forest Reservation Commission, these various appropriations, which are intimately connected with the work of the department, would, if added to the regular appropriations, make a grand total of $22,570,016 This is a large sum, but as was pointed out by Chairman Scott in concluding the presentation of the bill, "the money appropriated for the Department of Agriculture is an investment and not an expense And that it has been a good investment the statistics showing the expansion of agriculture and the improvement in methods throughout our country bear eloquent witness During these past ten years, while the Department of Agriculture has been expending $90,000,000, the farmers of the United States have added to the wealth of the world the stupendous and incomprehensible sum of $80,000,000,000 Without anything like a corresponding increase in the area of land under cultivation, the value of the farm products of our country has risen from slightly more than $4,000,000,000 ten years ago to nearly $9,000,000,000 in 1910

"The conclusion is inevitable, therefore—and that conclusion could be made incontestable by innumerable other proofs if time permitted—that the farmers of America are applying better methods and getting better results from their labors than ever before And in devising these better methods, in pointing the way for better results, the Department of Agriculture has been the undisputed leader, as it should be, and has thus beyond cavil or question derived from the money it has expended a percentage of profit to all the people which can not be calculated"

APPROPRIATIONS FROM THE BACHE FUND OF THE NATIONAL ACADEMY OF SCIENCES

DURING the past year the following grants have been made from the Bache Fund of the National Academy of Sciences

May 20, 1910 Franz Boas $300
Investigation of head forms of new born children

May 20, 1910 John A Parkhurst 500
Photometric and spectroscopic survey of circum polar stars

June, 1910 Louis T More 500
Continuation of investigation on discharge of electricity through gases, radioactivity and electro magnetic action (second appropriation, first made in May, 1908)

December 9, 1910 S F Acree 400
Investigation of reactions of alkyl halides with sodium ethylate

January 25, 1911 P W Bridgman 500
Effects of high pressure, variation of freezing point of liquids with pressure, compressibility of liquids and solids, and mechanical properties of metals

February 2, 1911 Francis B Sumner 250
Experiments on effects of external conditions on growing white mice

April 17, 1911 E W Washburn 200
To prepare and measure the specific conductance of pure water

April 17, 1911 Gilbert N Lewis 500
The determination of the electrode potentials of the alkali metals and of the metals of the alkaline earths

April 17, 1911 Charles C Adams 125
For the expense of completing and preparing for publication a paper entitled "The Geographic Variations and Relations of CO"

SCIENTIFIC NOTES AND NEWS

COLUMBIA UNIVERSITY has conferred its doctorate of laws on Professor C. F. Chandler, who retires this year from the chair of chemistry after forty-seven years of active service.

SIR WILLIAM T THISELTON-DYER, formerly director of the Kew Botanic Gardens, will receive the honorary doctorate of science from Oxford University on June 28

DR C S SARGENT, director of the Arnold Arboretum, Harvard University, has been elected an honorary member of the Société Nationale d'Acclimation de France, and an honorary member of the Royal Irish Academy

Dr Joseph H White, of the U S Public Health and Marine Hospital Service, was elected president of the American Society of Tropical Medicine at its recent New Orleans meeting

The trustees of the Jefferson Medical College, Philadelphia, on the recommendation of the faculty, have elected Dr Warren B Davis as the Corinna Borden Keen research fellow of the college This election carries with it an award of $1,000 for the purpose of a year's research work in Europe upon any subject approved by the faculty

A grant of two hundred dollars has been made from the C M Warren Fund of the American Academy of Arts and Sciences to Dr S F Acree, Johns Hopkins University, for the study of the physical and chemical properties of pure ethyl alcohol A grant, amounting in all to one hundred and fifty dollars, has also been made to Dr J E Gilpin, Johns Hopkins University, in aid of his work on the study of the nature and source of petroleum, which involves results on the fractionation of petroleum by means of selective absorption by porous materials, such as fuller's earth

Curator Bashford Dean, of the department of ichthyology and herpetology in the American Museum of Natural History, has been appointed the official representative of the museum at the twenty-second annual conference of the Museums Association, which will be held in Brighton, England, from July 10 to July 15, under the presidency of Mr H M Platnauer, B Sc, and at the one hundredth anniversary of the founding of the Universitas Regia Fredericiana at Christiania, which is to take place on September 5 and 6.

Professor Albert Johannsen, of the department of geology of the University of Chicago, will sail from Montreal on the seventeenth of this month to inspect the petrological laboratories of the principal European Universities.

Dr. C. H. Shattuck, head of the department of forestry at the University of Idaho, will during the coming summer conduct a forestal and floral survey of the Kaniksu National Forest This survey will be similar to that conducted by him last summer on the Clearwater National Forest The party will consist of twelve men with headquarters at Coolin, Idaho

Sir John Murray lectured before the California chapter of Sigma Xi on May 11 on "The Floor of the Ocean," using illustrations from the recent cruise of the Norwegian steamer *Michael Sars* in the Atlantic

The annual public address before the University of Michigan chapter of the society of the Sigma Xi, was delivered, June 2, by Professor J Playfair McMurrich, of the University of Toronto, the subject of the address being "Sir Francis Galton, his Life and Work" Professor F G Novy was elected president of the chapter

An address on "The Evolution of Human Teeth and their Racial Differences," was delivered by Dr A Hrdlicka, of the Smithsonian Institution, on June 1, at Toronto, under the auspices of the Ontario Dental Society, and on June 27 before the Alumni of the dental department of the University of Buffalo On May 25 a similar address was given by Dr Hrdlicka before the Maryland State Dental Association, at Baltimore

Mr A D Darbishire has been appointed to the newly instituted lectureship in genetics, at the University of Edinburgh, and will deliver a course of six lectures on heredity during the summer session

The statue to Captain Cook, the plans for which have been noted in Science, will be placed on the Mall side of the Admiralty arch, on the right hand going towards Charing Cross The execution of the statue has been entrusted to Sir Thomas Brock

The executive committee on the Chiene portrait fund has resolved to hand to the University of Edinburgh the balance of the fund, about $1,500, for the foundation of a bronze medal, to be called the "Chiene Medal in Surgery."

Dr. Edward Burnett Voorhees, professor of agriculture at Rutgers College and direc-

tor of the N J Agricultural Experiment Station, known for his important contributions to agricultural chemistry and agricultural education, died on June 6, aged fifty-four years

PROFESSOR WILLIAM RUSSELL DUDLEY, since 1893 professor of botany in Stanford University, died on June 4, aged sixty-two years

MRS. EMMA WILSON DAVIDSON MOOERS, custodian of the neuropathic collection of the Harvard Medical School, previously assistant pathologist in the Worcester and Maclean Hospitals, died on May 31

THE death is announced of Mr Robert Service, of Dumfries, Scotland, who while conducting the work of a nursery made valuable contributions to ornithology

THERE is existing a vacancy in the position of physical chemist in the Bureau of Mines, Department of the Interior, at Washington, D C This position requires a high order of scientific training equivalent to that required by the leading American universities for a professorship in physical chemistry A man is wanted who will be able to organize, to participate in, and to supervise the physical and chemical investigations of problems that serve as a basis for modern metallurgical methods, especially the problems connected with the ores, operations and products of modern smelters The government is endeavoring to find the best man available for this work and has no particular individual in view The methods of procedure will be similar to those of an educational institution or business organization, whose board of trustees or governing officers desire to fill professional or technical positions The qualifications and fitness will be determined by an impartial board of scientific men The entrance salary for this position is $4,000 per annum There is also existing a vacancy in the Bureau of Mines in the position of chief mechanical engineer, at an entrance salary of $4,800 per annum For this position it is desired to secure a man who will be able to participate in and supervise the various mechanical engineering problems appropriate to the work of the Bureau of Mines, including investigations looking to a greater efficiency in the utilization of mineral fuels at the various heating and power plants of the government in different parts of the country, and the mechanical problems connected with various mining operations Qualified persons who are interested in these positions are invited to communicate with the U S Civil Service Commission, Washington, D C, at an early date, since the selections will be made about the middle of July

ACCORDING to a bulletin issued by the Bureau of Statistics the month of May was not, on the whole, very favorable for crop growth, drouthy conditions having prevailed over a great portion of the United States In consequence the average condition of crop growth in the United States on June 1 was 2 8 per cent below the average condition on that date Some relief from the unfavorable conditions came at the close of May and first part of June A comparison of the conditions of various crops on June 1, with their average growing condition on June 1 of recent years (past ten years for most crops) is shown as follows (100 representing average conditions and not normal) cotton 108 5, sugar beets 103 2, apples 102.5, raspberries 101 8, spring wheat 101 1, watermelons 100 6, pears 99 7, cantaloupes 99 6, blackberries 99 5, sugar cane 99 5, barley 99 2, winter wheat 98 5, rye 98 2, oats 96 9, alfalfa 96 1, onions 95 5, lima beans 92 5, cabbage 91 0, pastures 90 2, hemp 89 0, clover hay 84 6, all hay 85 1, peaches 83 5 The above figures relate only to relative growing conditions, not taking into account changes in acreages Taking into account both acreage and condition, indications are for about 9 9 per cent larger wheat crop than was produced last year, and 10 2 per cent larger than the average of the past five years, oats crop 13 3 per cent less than last year, but 4 8 per cent more than the average of the past five years, barley 8 per cent more than last year, and 5 3 per cent more than the five-year average Total areas have not been estimated for the other crops, except that the rye area planted is about 1.2 per cent. less

than last year Clover (for hay) acreage 6 3 per cent less and sugar cane acreage 0 4 per cent more than last year

UNIVERSITY AND EDUCATIONAL NEWS

The Harvard Medical School has been bequeathed $22,000 by the will of the late Professor Samuel Hubbard Scudder, the eminent entomologist

Governor Dix has signed a bill that appropriates $235,000 for the state colleges of Cornell University The Veterinary College receives $140,000 for a new building and $50,000 is appropriated for a heating plant This bill is independent of the annual bill for maintenance, which has not yet been passed

At the Bryn Mawr College commencement announcement was made of a bequest of $150,000 from Phoebe Anna Thorne, of New York, who died in 1909, to endow an associate professorship of education and the Phoebe Anna Thorne Model School to be conducted by the college as an experimental high school in connection with a graduate school of education.

Columbia University has received a gift of $10,000 annually for five years from Mr Charles H Davis, C E ('87), for the support of advanced instruction in highway engineering and Professor Arthur H Blanchard, of Brown University, has been appointed professor of highway engineering. Among other gifts announced are $45,000 from the committee appointed to raise the Richard Watson Gilder Memorial Fund to establish the Gilder fellowships in good citizenship, $33,133 from the committee appointed to raise the William T Bull Memorial Fund, to establish a fund for research in surgery, and $20,000 from an anonymous donor for the equipment of the research laboratories in electro-mechanics

Dr Eugene A Noble, president of Goucher College, has been elected president of Dickinson College

Miss Ellen Fitz Pendleton, dean, acting-president and associate professor of mathematics of Wellesley College, has been elected president of the institution.

Dr Michael I. Pupin, professor of electromechanics in Columbia University, has been designated to serve as director of the Phœnix Research Laboratories In this capacity, Professor Pupin will be in general charge of the development of the research work in the department of physics

In the School of Education of the University of Pittsburgh the following appointments have been made Henry Davidson Sheldon dean of the School of Education in the University of Oregon, has been made professor of the history of education Dr Sheldon will spend next year in Europe on leave of absence and will take up his work in Pittsburgh in the fall of 1912 Charles Barr Robertson, director of the schools of practise and professor of psychology and education in the Cortland, N Y, State Normal School, has been called to the professorship of secondary education, and will organize and direct the practise teaching and the cooperative relations of the high schools and the university

The Johnston scholarships, of the Johns Hopkins University, "offered primarily to young men who have given evidence of the power of independent research," have been awarded by Johns Hopkins for 1911–12 to James Ryals Conner, Ph D, in mathematics, Franklin Edgerton, Ph D, in Sanskrit, and Joseph T Singewald, Jr, Ph D, in geology The Adam T Bruce fellowships, bestowed upon candidates who are considered "most likely to promote biological science, and especially animal morphology, by original research," have been awarded to Elmer J Lund, Ph B, in botany, and David H Tennent, Ph D, in zoology

Dr Frederick P Lord, of Iowa City, formerly connected with the department of anatomy of the State University of Iowa, has been appointed as the head of the department of anatomy of Dartmouth Medical School

Dr J F Shepard has been promoted from instructor to assistant professor of psychology at the University of Michigan.

A new chair of machine design has been created in the engineering department of the University of Michigan, to which Professor Woldenburg, of Charlottenburg, Germany, has been appointed.

MR ROBERT NEWSTEAD, lecturer in economic entomology and parasitology in the Liverpool School of Tropical Medicine, has been appointed to the newly-established Dutton Memorial chair of entomology in the University of Liverpool

DISCUSSION AND CORRESPONDENCE

VITALISM AND EXPERIMENTAL INVESTIGATION

IN connection with the recent helpful discussions of vitalism by Ritter[1] and Lovejoy,[2] one point seems worthy of further emphasis Some men are interested in science because of its bearing on general philosophical problems, others are interested in philosophical problems because of their bearing on the way to go to work in science Both attitudes are proper enough, but one's treatment of such a question as vitalism is largely determined by which of these attitudes he takes The point I wish to emphasize arises from the second attitude Has vitalism (in any of the brands set forth by Lovejoy) any bearing on the theory and practise of scientific investigation?

This is a practical question in which the experimentalist as such must be interested, even though he may pride himself on his indifference to philosophical speculation One kind of vitalism appears to me to affect fundamentally the theory of scientific work, for this reason this kind appears of more interest than the other, if not the only kind worth distinguishing

The man of science at work with his two hands is trying to find the determining conditions for what takes place in matter and energy, and how these conditions act In so doing he is led to make a study of the various possible methods of work, and particularly of the various ideas and devices that are presented to him as deserving consideration in his work Many such things come to the worker in biology from outside his own special field; particularly from physics and chemistry Such were the theories of electric dissociation; much in the physics of colloids, and the like. The biologist is compelled to examine these to see how useful they are in his own experimental analysis, often he finds them of the greatest value and he modifies his methods of work accordingly

Various theories of vitalism have likewise been brought to the attention of the investigator, but as a rule he has taken little interest in these, because they seemed of such a nature as not to affect his work, they seemed merely general suggestions and reflections on the fundamental meaning of what one sees in biology, of interest primarily to the man for whom science is the handmaid of philosophy, rather than the reverse They did not attempt to provide an instrument for actual use in experimentation, nor an idea according to which scientific practise must be altered

This appears to be the case with the first kind of vitalism distinguished by Lovejoy, a vitalism which holds that there are new modes of action in living things, but that the new modes of action are nevertheless functions of the configuration of the matter and energy involved, so that after we have discovered how a given physical configuration acts, we can depend upon it, as we depend upon such constancy in the inorganic sciences Such a vitalism involves no fundamental change in our methods of work, we continue to test, by fitting methods, how given configurations act, and to record the results in proper generalizations, exactly as in physics and chemistry Biology would then, so far as scientific method is concerned, bear the same relation to physics and chemistry that any unexplored part of these sciences bears to the explored parts. The distinction between vitalistic science and physical science would have but a very mild interest for the worker with his hands; it has no pragmatic bearings

On the other hand, the second kind of vitalism distinguished by Lovejoy makes assertions which would if true require serious consideration in actual practise, indeed, it is put forward by its advocates as supplying certain factors which require consideration on the same grounds as do electric dissociation and osmotic pressure; factors without which our experimental analysis is bound to be incomplete or wrong. Its acceptance would logically

[1] SCIENCE, March 24, 1911

[2] SCIENCE, April 21, 1911

produce fundamental changes in the principles of experimentation This is the point which, to me as an experimenter, seems hardly to receive adequate consideration by Professor Lovejoy; this appears to me the reason why this particular kind of vitalism (the vitalism of Driesch) has received so much attention from investigators, though as a rule they are rather indifferent to vitalistic theory This is the vitalism which holds that the laws of what occurs in organisms "can not even be stated in terms of the number and arrangement of the organism's physical components."[3] This statement means, if it means anything, that you can not make a statement *which will hold*, that a given arrangement of physical components will act in a certain definite way (even after you have observed how it acts) If such a statement will not hold, this can be only because the same arrangement of physical components acts sometimes in one way, sometimes in another—so that there results indeterminism so far as the physical components are concerned[4] If vitalism of this sort is correct, then the biologist can not from a knowledge of the total physical configuration predict what will happen, even after he has observed it

To realize the situation in which this leaves the experimenter, it is needful to consider just what his work consists in The experimental investigator is engaged in discovering the determining causes of things Just what we are to understand by *cause* has given rise to much discussion, often leading far away from any experimental concept[5] Experimentally it means any preceding event or condition without which the event we are studying would not have occurred Now it turns out in experimentation that everything has a very great number of such "causes," all standing on the same experimental footing, so that to determine "the cause" of any event, taken by itself, is a hopeless task, so taken, the meaning of *cause* becomes undefinable, unless it could be held to signify finding out everything that must have happened in order that this event may occur Progress can be made only when we so state our problem that we need search for but one determining cause at a time Now, *one single sufficient experimental cause can be found only for the difference between two cases,* and the actual practise of experimental investigation consists in comparing two cases and finding experimentally what determines the difference between them, discovering, that is, what preceding difference results experimentally in producing the present difference

An example will make this clear An organism is observed to move over a certain stretch, from *a* to *b* What is the cause of this? The question so put opens up a vast perspective, we may go into the production of the energy which brings about the movement, with the infinite number of questions that this involves, we may study the special organs by which this organism performs its movements, and how these organs were produced, we may take up the stimuli which set the organism in motion, and those which determine its direction, the environmental conditions on which the motion depends, etc All biological science is before us, where shall we take hold? We must make our question precise, and this can be done by considering two differing cases This specimen now swims in a certain direction, this other (or this same one at a different time) in a different direction What is the cause *of this difference?* A little experimentation shows that the one, only and sufficient cause is the different direction of the rays of light in the two cases Or, again, this specimen swims in a certain direction, while

[3] Lovejoy, *l c*

[4] A natural result of this is to do what Driesch does and what Lovejoy seems inclined to deprecate, to assume the existence of some non-physical factor, as entelechy, to supply the missing differential determining condition This grows out of the ordinary procedure in experimental investigation; whether it really helps the experimenter in his work we shall inquire in a moment

[5] The ambiguities in the word cause have induced some investigators to drop it entirely, and deal only with words having no implication that is not definable in experimental terms, so Verworn in the fifth edition of his "General Physiology"

this other does not, even though the direction of the rays of light is the same What is the cause of *this* difference? Experiment shows it to be the different temperature in the two cases In another case the difference in motion is found to be due to difference in chemical conditions, or to difference in the amount of food taken, or the like Many times we find that there are two or more different factors, any one of which will produce the difference in question, or that the observed difference will not result unless two or more determining factors are combined These are only details of application, the method throughout is to take two cases differing in a certain respect, then to find the (experimental) determining cause for this difference By continuing this process, comparing all possible degrees of difference, the causal analysis may be carried to any desired degree of minuteness —till the smallest perceivable differences are reached The process may be continued backward, tracing step by step how the determining differentials for any given case are themselves determined, until we have as full an experimental analysis as we desire, there being no end to the process of analysis, save as practical considerations compel us to stop[6]

The investigator may of course not always actually have the two cases present before him, he may not even think of the concrete existence of more than one of the cases, but the rationale of the process, when analyzed, is that which we have set forth[7]

Now, the fundamental principle on which this work of the investigator is based is this *When two cases differ in any respect, there will always be found a preceding difference to which the present difference is* (experimentally) *due* This principle is, explicitly or implicitly, constantly present with the experimenter If two experiments, supposedly alike, give different results, *there must be some preceding difference to account for this* The investigator is so convinced of this that it does not occur to him to doubt it or state it or consciously raise the question at all, he merely sets to work to find what the difference is, and he may spend hours or days or years in his search This principle is the air the experimenter breathes, the water he drinks and the food he takes It is what makes him an experimenter If he should become convinced that it does not hold, the logical thing for him to do is to follow the finely consistent example of the sponsor for the kind of vitalism that asserts that it does not, and drop experimentation to take up philosophy

The question whether this principle is correct need not concern us now, what I wish to bring out is the tremendous difference in scientific investigation in two fields, in one of which this principle holds (as it is supposed to do in physics and chemistry), while in the other it does not (as in biology, according to this sort of vitalism) The investigator in the field where it does not hold would be continually in doubt as to what to do Here are two experiments that result differently But is it worth while to search for an experimental determining factor for this difference? Perhaps there is no such factor—for this is biology, not physics The guiding principles are different in the two fields; while we might in physics be certain that an experimental cause could be found for the difference, in biology we can not, for in biology the same configuration may give sometimes one result, sometimes another This is a difference in principle that would really make it worth while to separate the two sets of sciences in a fundamental way; this would give us a vitalism that had some practical consequences.

But what should be the further procedure of the biologist in view of the fact that two complexes absolutely identical in their phys-

[6] The farther work, of comparing the results of this analysis and recording them in fitting generalizations, by which the heap *of facts is* reduced to an ordered whole, does not concern us here

[7] Thus, when the investigator merely asks What determines the *direction* of this movement—the experimental question essentially is, When this specimen moves in a certain direction, while another does not, what determines the difference between the two cases? Neglect to analyze problems into this form leads to much of the inconclusive work and difference of opinion in experimental biology.

ical[9] make-up give different physical results? Shall he abandon the principle of "univocal determination," not merely from a practical experimental standpoint, but completely? Or shall he follow Driesch's example and try to save the principle by assuming that the two cases differ in something non-physical (which he may call entelechy if he likes the word)? Professor Lovejoy's suggestion that this latter is a hypostasis hardly warranted in strictly scientific procedure, would leave us absolutely without determining cause for the difference, the experimenter could but admit the failure of the principle on which his work is based, lay down his arms, and surrender But does Driesch's assumption of a non-physical differentiation between the two cases leave the experimenter in a better situation?

Driesch's statement to save the principle of determinism in such a case is as follows. "given certain circumstances, and given a certain entelechy in a certain state of manifestation, there will always be or go on one specifically determined event and no other"[9] Thus under the conditions we have sketched, the investigator could comfort himself (if he found it a comfort) with the assertion that different entelechies were at work in the two cases, or that the same entelechy was at work in different manifestations (the latter formula would be forced upon us by the vitalistic arguments from behavior) Now, what is the difference between attributing experimental results to such non-physical determiners, and the ordinary experimental procedure of attributing them to physical determiners?

The difference lies in two points (which are perhaps fundamentally one) (1) Any physical factor has various manifestations, the conditions for each of which are discoverable and constant, it is bound up in many different ways with the rest of the conditions Hence if the experimenter attributes a result to a certain physical factor, this is at once open to test, we may try whether its other manifestations appear as they should if it is in presence, it leads at once to farther experimentation, and the explanation must stand or fall in accordance with the results of this experimentation On the other hand, the non-physical entelechy may give different manifestations (or none at all) under the same conditions, there is no way that we can test the affirmation that a given experimental result is due to it A physical factor that showed itself in one unique manifestation, and might later show itself under the same conditions in a different manifestation would of course leave the experimenter as helpless as does entelechy, but such a "physical factor" is a contradiction in terms, it is because entelechy has this character that it is a non-physical factor[10] Thus attribution of a result to entelechy closes the door to farther experimental test

2 In experimenting in non-vitalistic fields, after we have discovered what preceding differences determine (experimentally) our given diversities, we may move a step back and discover in the same way what determined those preceding differences, and this process of carrying back the experimental analysis is without end (save from practical difficulties) On the other hand, as soon as the experimenter has attributed his observed diversities of result to different manifestations of entelechy he is at the end of his experimental rope What determines, under the same physical conditions, the different manifestations of entelechy? The problem is not only practically, but by hypothesis, beyond the reach of experimentation[11]

[8] I am throughout using the word *physical* in place of "physical and chemical," "physical or chemical" and "physico chemical"

[9] "The Science and Philosophy of the Organism," II, 153–154.

[10] If, as some have suggested, entelechy is to be considered merely a name for a factor whose dependence on the rest of the conditions and whose uniformity of action is not yet known, we should of course by this assumption drop our vitalistic theory; it is by vitalistic hypothesis that entelechy has the peculiarities mentioned above

[11] "Organic systems are governed by entelechy, and therefore contain all possible future perceptible diversities in an *imperceptible* form," Driesch, "Science and Philosophy of the Organism," II., 198.

Thus the bringing in of entelechy as a determiner is at most a pad to soften the experimenter's fall, a way of distracting his attention for a moment from the dolorous fact that his method of work has failed It merely puts off for one single step the admission that the principle on which experimental investigation is based breaks down when applied to biology Physical science and vitalistic science are then distinguished by a fundamental difference in the principles of investigation, of the highest practical consequence

Some attempts are made to console the biological experimenter for this difficulty, to make light of the difference in investigation in the two fields Professor Lovejoy comforts us by saying that in the case of the developmental processes on which Driesch partly bases his argument you could "if you go back to an early enough stage in the given sequence of processes" find "perfectly definite, perceptible and experimentally ascertainable constant antecedents" for the observed procedure, this in view of the fact that men do not gather figs of thistles, nor whales of sea urchin's eggs, to get a given type of adult you must at least have the egg of that type Thus only that immense field of developmental processes which lies between the egg and the adult would be exempted from experimental determinism! This might yield some solace to those whose life work does not lie in this field, were it not that Lovejoy quite leaves out of account Driesch's arguments and conclusions for the other fields of animal activities, particularly for behavior In behavior, according to Driesch's vitalism, what the animal does depends as much on the non-physical entelechy as it does in development, and yet there is no single type toward which each act tends.[12]

Again, some have assured the writer that we may accept this kind of vitalism and still go ahead with our work just as if experimental determinism still held, that in fact cases where it doesn't hold probably occur only under rare and recondite conditions, which we may never meet This vitalism, reserved like the religion of some individuals for Sunday consumption only, receives no encouragement from any close examination of vitalistic theory Taking as an example Driesch's working out, we find that we may expect the vitalistic factor to show its action continually in all sorts of work with living things According to Driesch the precise work of the vitalistic factor is to "suspend for as long a period as it wants any one of all the reactions that are possible with such compounds as are present, and which would happen without entelechy And entelechy may regulate this suspending of reactions now in one direction and now in the other, suspending and permitting possible becoming whenever required for its purpose This faculty of a temporary suspension of inorganic becoming is to be regarded as the essential ontological characteristic of entelechy"[13] That is, when there are in juxtaposition a number of substances which, according to purely chemical laws, would interact, giving certain results, entelechy may (or may not) interfere, preventing the union of certain of these, until the resulting products are determined by those that have been allowed to interact Thus from the same mixture of chemicals we shall get sometimes one product, sometimes another (depending on the purposes of entelechy); the variety of results thus obtainable from a given complex is of course very great. Now, all living things are complexes of great numbers of

[12] Thus Professor Lovejoy can not be followed when he states that "All that Driesch maintains is that such a [morphogenetic] process once started continues toward its normal consummation even if, after the start, some of the usual machinery instrumental to the consummation is lost and the rest has to redistribute and redifferentiate itself in order to keep things moving in the customary manner." This is only one of the observed facts on which Driesch bases his vitalistic theory, he has published an entire book on vitalism in behavior, and a large proportion of "The Science and Philosophy of the Organism" is devoted to the same subject One gets a very inadequate idea of the real nature of his theory by supposing it limited to morphogenesis, his conclusions reach far beyond this

[13] "The Science and Philosophy of the Organism," II, 180

chemicals, so that the condition under which entelechy comes into play is always realized. We may therefore expect its action at any step in our work; we must be prepared at all times to find the same physical configuration giving rise now to one result, now to another; we can have no confidence that when two experiments give different results, it will be possible to find an experimental cause for this difference.

Doubtless there are investigators who can persuade themselves that they really believe this sort of thing, and yet who can continue hopefully their hopeless task of trying to discover experimentally the conditions that determine what happens—just as there are persons who assert that they believe certain orthodox religious doctrines and yet live cheerfully the life of the worldly. But for one who takes his experimental work seriously and who has use for theories only as *theories of practise*, the acceptance of such a doctrine can not fail to profoundly change his work and his attitude toward his work.[14] It takes away the guiding principle on which every step of his work is based.

Thus a doctrine which holds to consistent physical determinism in the inorganic sciences and rejects it for biology makes a tremendous difference in principle between the two fields, a difference big with practical results. I believe that to most working investigators of biology the question of vitalism means the question whether there is such a difference, and it appears unfortunate that this question should be obscured by confusing it with the (for the working investigator) relatively inconsequential question as to whether anything happens in living things that doesn't happen in those not alive.

H. S. JENNINGS

JOHNS HOPKINS UNIVERSITY,
May 16, 1911

[14] Of course there would still be work for the biologist. Descriptive and observational work would be little affected. The biologist could substitute "entelechy" for "god" or "providence" or "nature" in the pious expositions of the naturalists of two generations ago, and devote himself to showing the wonderful and unfathomable ways of entelechy. If of an incurably analytic turn of mind he could even examine the limitations which the physical conditions place upon entelechy, and perhaps make a catalogue and classification of the various results produced by entelechy from a given physical configuration. It is the principles, methods and objects of experimentation that would be changed.

THE APPLICATION OF THE METHOD OF LEAST SQUARES

TO THE EDITOR OF SCIENCE: It would, I think, be interesting and valuable to have a consensus of opinion from both astronomers and physicists as to the limits within which the application of the method of least squares is permissible. This method is used widely by astronomers and but rarely by physicists. Moreover, I believe most physicists would hesitate to push the application of the method as far as is commonly done by astronomers.

To take a concrete case. During the discussion that followed the Saturday afternoon symposium at the recent general meeting of the American Philosophical Society, one point under discussion was whether or not the principle of relativity requires the abandonment of the concept of the ether. The writer mentioned as an *experimentum crucis* the possibility of detecting an ether-wind by measuring the speed of light in a single direction and over a path which for its greater part lay remote from the surface of the earth, thus avoiding a limitation of the Michelson-Morley experiment. It was suggested that if the measurement of the speed of light by Romer's method could be carried out with sufficient accuracy, and at two such times that the light would have to travel with and against the proper motion of the solar system, such an ether-wind might be observed. It was pointed out that the difference of time to be expected would be of the order of one fifteenth of a second. Some doubt was expressed as to whether this accuracy was yet attainable in a difficult measurement of this nature.

To this Professor Pickering replied that a large mass of such data was already in the possession of the Harvard Observatory, and had been discussed and reduced with this very

point in mind, and with a negative result In response to a query from Professor Doolittle as to the precision of the observations Professor Pickering stated from recollection that the error of a single observation might be three or four seconds, but that the hundreds of observations available brought the probable error well within the precision required

It seems to me there is room for an honest difference of opinion as to the value of the method of least squares in a case like this, where the error of a single observation may be forty-five or more times as great as the quantity to be detected Surely we must draw a line somewhere

While I have given this point no extended investigation, I may formulate my own opinion, as a basis for discussion, in the form of a mathematical theorem

The value of the measure of precision obtained by applying the method of least squares varies inversely as the ratio e/q (where $e =$ error of a single observation and $q =$ quantity to be measured), in such a manner that when $e/q = 1$ the value is zero, and for $e/q > 1$ the value is wholly imaginary

PAUL R HEYL

DR BRUSH'S THEORY OF GRAVITATION

TO THE EDITOR OF SCIENCE The article by Dr Brush on "A Kinetic Theory of Gravitation" in SCIENCE of March 10, will become of great interest to physicists when the author does what he partly promises to do in a future paper, viz, explains how a body which is perfectly transparent to a given radiation can shield another body from that radiation, and why, if the other body is also perfectly transparent, it makes any difference whether it is shielded from the radiation or not It would appear to be immaterial, so far as the effect upon the body is concerned, whether the atoms of a body through which this radiation is streaming in all directions are "buffeted about in every direction by the ether waves in which they are entangled" or whether they remain undisturbed by these waves, so long as they do not absorb any energy from the radiation

Dr Brush says that in the former case, "Each atom or molecule may be regarded as a center of activity due to its kinetic energy of translation, with continual absorption and restitution of the ether's energy normally equal in amount" This seems to the present writer equivalent to saying that a perfectly transparent body may be regarded as one in which the atoms are continually absorbing and radiating equal quantities of the same kind of energy If anything can be gained by making such an assumption, there seems to be no objection to making it, and I, for one, shall look forward with interest to Dr Brush's explanation of how it will enable such a transparent body to cast a shadow

FERNANDO SANFORD

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SCIENTIFIC BOOKS

Soil Fertility and Permanent Agriculture By CYRIL G HOPKINS, University of Illinois Pp xxiii + 653, 14 illustrations, 3 colored maps Boston, New York and London, Ginn & Co Price $2 50

Of this work the author says "The chief purpose of this volume is to bring together in convenient form the world's most essential facts, gathered from the field and laboratory, and to develop from them some foundation principles of permanent agriculture" The book is a notable contribution to the foundations of practical agriculture, treated in an introduction and four parts, I, Science and Soil, II, Systems of Permanent Agriculture, III, Soil Investigations by Culture Experiments, IV, Various Fertility Factors

The method of treatment adopted is admirable but not that usually chosen by writers on either soil or agricultural chemistry The book takes a distinct place in agricultural literature and will be found a mine of information and valuable reference to the subjects it treats Professor Hopkins holds persistently throughout the volume to the thesis named in the title and does not aim to treat in detail a wide range of topics, but has built his treatment upon a broad, most substantial

foundation of germane data, thoroughly and logically cemented The 121 tables of foundation data are mostly the results of well conceived, long continued, carefully measured and verified experiments, executed both in Europe and in this country They are not only put into effectively illuminating form by the author and discussed, for his purpose, with good discrimination, but they will be found most valuable references for many other purposes

Some will question the wisdom of recalculating the data of some of these tables on the basis of the elements but there can be no doubt that this method serves much better for comparative study, and had earlier investigators adopted the plan no serious criticism would be urged We feel that the author should have gone a step farther and expressed all results on the basis of weight and of dry weight, wherever possible The amounts of plant food elements and of water removed from the soil by a bushel of potatoes, oats and wheat have no proper comparative relation, as they do when expressed on the basis of dry substance

Within the last few years there has been such a pronounced growth of public appreciation regarding the importance of the maintenance of soil productivity that plant physiologists, pathologists and geologists, with others, are following the lead of bacteriologists in efforts to see if in their fields there may not exist relations which will enable their observations to shed important light on the complex problems involved This is progress along hopeful lines and such investigators may feel that the volume before us does not give sufficient prominence to these newer lines of research But as Professor Hopkins has written for the educated farmer, and from the standpoint of every-day field practise, he has wisely chosen not to obscure that which has been proven by prolonged careful research, checked by practical experience, with the presentation of theories suggesting practises not yet tried, which may or may not prove helpful.

Ten chapters are devoted to science and soil, in which fundamental facts and principles are stated, followed by presentations regarding plant food elements and compounds, plant food and the earth's crust as an original source, and soil formations and classifications, two maps being given, one for Illinois and the other for the United States The composition of soils in general is treated, followed by that of soils of eastern, central, northern, southern and western United States, expressing the results in amounts contained in two million pounds of dry surface soil, or approximately that contained in an acre to the usual depth of plowing Ten residual soils of Maryland are shown to carry 720 to 1,500 pounds of phosphorus, while the Illinois soils range between 810 and 2,030 pounds per two million pounds of dry soil These amounts Professor Hopkins considers would be removed by approximate maximum crops in a rotation of wheat, corn, oats and clover in from 37 to 105 years, or if only the grain is sold, in from 68 to 192 years

It is highly probable that no normal soil can experience the withdrawal of any considerable proportion of its phosphorus without suffering material reduction in producing power, and if so, even if it be true that the phosphorus in the second, third and fourth feet participates equally and continuously in crop production, permanent agriculture with undiminished yields must be impossible except through restoration in some manner Professor Hopkins considers that usually there is no natural process of restoration sufficient to maintain high yields, and closes the first part, only after considering crop requirements for nitrogen, phosphorus and potassium, together with sources of plant food, thus providing quantitative data for the discussion of systems of permanent agriculture, treated in seven chapters

In introducing the subject he says:

For practically all of the normal soils of the United States, and especially for those of the central states, there are only three constituents that must be supplied in order to adopt systems of farming that, if continued, will increase, or at least permanently maintain, the productive power of soil. These are *limestone, phosphorus* and *organic matter*. The limestone must be used to

correct acidity where it now exists or where it may develop The phosphorus is needed solely for its plant food value The supply of organic matter must be renewed to provide nitrogen from its decomposition and to make available the potassium and other essential elements contained in the soil in abundance, as well as to liberate phosphorus from the raw mineral phosphate naturally contained in or applied to the soil

It should be said here that throughout the work Professor Hopkins is concerned only with general farming, not with intensive agriculture where other fertilizers can be used with profit and must be if largest results are secured

Chapters are given to the discussion of limestone, of phosphorus and of organic matter and nitrogen, as to their function, quantitative needs and maintenance Then follow chapters on rotation systems for grain farming, live stock farming, the use of phosphorus in different forms and finally theories concerning soil fertility The subject-matter of these chapters is of the greatest importance, the views presented are in the main fundamentally sound, they are well presented and must have a very important influence in advancing agriculture in the United States

Part III contains an admirable digest of the more important field experiments bearing upon permanent agriculture, conducted at Rothamsted, England, in Pennsylvania, Ohio, Illinois, Minnesota, in the south and in Canada, pointing out their bearing upon the views expressed in the preceding sections

Professor Hopkins has succeeded in producing a worthy companion volume to Hilgard's great work "Soils"

F H KING

MADISON, WIS,
May 16, 1911

The Ice Age in North America and its Bearing upon the Antiquity of Man By G. FREDERICK WRIGHT Fifth edition, revised and enlarged. Pp 800 200 illustrations 8vo, cloth.

The popularity of Wright's "Ice Age" is sufficiently attested by the fact that the fifth edition is now published under date of December 22, 1910, enlarged and embellished with many new and interesting illustrations

The value of Professor Wright's work consists principally in the illustrations and descriptions he gives of glacial phenomena not only in North America, but in other portions of the world The main criticism of this work, which has many good features, is that its author is too credulous, and has thus permitted many exploded "chestnuts" like the Calaveras Skull," the "Lansing Skeleton" and the "Nampa Image" to find in him a defender of their antiquity. This tendency of Professor Wright is unfortunate, since it of itself throws doubt upon his power of critical discrimination in analyzing evidence pro and con in matters of geologic controversy It is possible that Professor Wright's theological beliefs have unconsciously biased his judgment in matters pertaining to the age of the earth and to the date of the glacial epoch In spite of these defects, however, Professor Wright's "Ice Age in North America" will prove a useful work in enlisting popular attention, and study of these most interesting phenomena connected with the Pleistocene glaciation

I C WHITE

SPECIAL ARTICLES

A SCALE FOR MEASURING THE MERIT OF ENGLISH WRITING

ONE inch may be said to be equal to another inch from any one of three lines of evidence If the two are compared by a hundred experts, (1) the experts will all report the two as indistinguishable, or (2) if some of them do, by microscope, micrometer or the like, find a difference of a trifle plus or minus, the number finding the first inch plus will equal the number finding it minus, or (3) if each man is forced to report a difference, half will find the first inch plus and half minus

One specimen of English writing may be said to be equal to another from the second or third lines of argument, the only logical difference between equating the two lengths and equating the two specimens of writing being that the variability of expert judges in the

latter case is so great that we never find all of them, and rarely find many of them in agreement, as to the indiscernibility of any difference. But specimens 571 and 220 below are, in merit as defined by, say, 100 competent persons, approximately equal, since if asked to report 571 as better, equal to, or worse than 220, there will be a large proportion of equals and the judgments "better" will approximately equal the judgments "worse." Of 110 competent persons, forced to make a distinction, 54 favored sample 571 and 56 sample 220.

571. VENUS OF MELOS

In looking at this statue we think, not of wisdom, or power, or force, but just of beauty. She stands resting the weight of her body on one foot, and advancing the other (left) with knee bent. The posture causes the figure to sway slightly to one side, describing a fine curved line. The lower limbs are draped but the upper part of the body is uncovered. (The unfortunate loss of the statue's arms prevents a positive knowledge of its original attitude.) The eyes are partly closed, having something of a dreamy langour. The nose is perfectly cut, the mouth and chin are moulded in adorable curves. Yet to say that every feature is of faultless perfection is but cold praise. No analysis can convey the sense of her peerless beauty.

220. GOING DOWN WITH VICTORY

I sat on the top of a mail coach in Lombard street impatiently awaiting the start. 'Twas the the night of the victory and we would help spread the news over England.

Up jumps the coachman followed by the guard, an instant's preparation, a touch of the lash and we are off! We are soon past the limits of the city out in open country, galloping, tearing along, a clear road ahead of us for the English Mail stops for nothing.

We dash in at villages, stopping but a moment with the mail, shouting the news of the victory and we are off again. Proud were we and had we not a right to be? The first to carry the great news through the land!

The memory of that ride is ever fresh in my mind and I will ever remember those hours as the most glorious in all my life.

The difference between 1 inch and 2 inches is said to be equal to the difference between 2 inches and 3 inches, because the experts will, as before, all agree or divide equally in their disagreement. The essential logic of their procedure will appear if we change the illustration.

Let their task be to examine the following pairs of lengths: I. (*a*) 10.0000 inches, (*b*) 10.0001 inches, II. (*c*) 10.0001 and (*d*) 10.0002, III. (*e*) 10.0001 and (*f*) 10.0003, IV. (*g*) 10.0001 and (*h*) 10.0004, V. (*i*) 10.0001 and (*j*) 10.0005, and to judge in each case whether the second line of the pair is shorter, equal, or longer. We shall find that even the experts make some wrong judgments with these very small differences, but that the proportion of right judgments increases as the difference increases, so that we can conclude that the difference between (*a*) and (*b*) is equal to the difference between (*c*) and (*d*), not because it is always judged so, but because it is *equally often* judged so, by experts. The basis for the scientific acceptance of a difference may then be that judgments of longer are more frequent than judgments of shorter. And the basis for the scientific acceptance of one difference as equal to another difference may be that the preponderance of judgments of longer is equal in the two cases. This is not the whole truth of the matter in the case of the equality of such differences as 1.0001 in. – 1.000 in. and 1.0002 in. – 1.0001 in., but it is a part of it.

This part of it may be made true of judgments of differences in merit in English writing. For instance Specimen 627 is judged to have more merit as writing by young people in their teens than specimen 570 by 83 out of 110 competent persons. Specimen 570 is also judged to have more merit, similarly defined, than Specimen 603 by 82 out of the same 110 competent persons. The difference between Specimens 627 and 570 is then approximately equal to the difference between Specimens 570 and 603.

627. A SCENE

I think the sunlight is very beautiful on the water, and when it shines on the water it is very beautiful, and I love to watch it when it is so beautiful. The colors are so pretty and the noise

of the water with the sunshine are so attractive in the sunshine I wonder do other people love to watch the water like I do I don't know as there is anything as lovely as the water waves in the sunlight of the glorious orb

570 DESCRIPTION OF SCHOOL ROOM

Our school room is on the side of the school house and it is a awfully nice room and I like it because it is so nice and all the boys like it, there is a good many pictures on the wall and there is a clock on the wall We like this school room and come to school most all the time

603 A CHARACTER SKETCH

The man I am describing is a white man and he has nice hair and wears a hat, and his horse is black, I like this man and he has two eyes and his nose is red

In this way it would be possible to discover specimens of English writing ranging from Specimen 607 (which may roughly represent zero merit in English writing by young people in their teens) up to the best writing known, by equal steps, so that Specimens 0, 1, 2, 3, 4, and so on, would have in part, the significance for merit in English writing that 0 inch, 1 inch, 2 inches, 3 inches, and so on have for length

607 SKETCH

I words four and two came go billa gum sing hay cows and horses he done it good he died it goon I want yes sir yes sir oxes and sheeps he come yes sir camed and goes billum gumun oomunn goodum

Such a series of specimens representing defined degrees of merit in composition would be of service to civil service examiners, college entrance examination-boards, high-school teachers of English, and any others who were concerned with measuring ability to write English, the changes produced in that ability by various forms of training, or the differences in it that distinguish certain groups

An investigation designed to establish such a scale is now being made by Mr M. B Hillegas and myself We should be very glad if any of the readers of SCIENCE would cooperate to the extent of sending us their ratings of the ten specimens printed below. All that is required is that the reader consider these as specimens of English writing by young people, choose the one that seems to him to have the least merit, number it 1, choose the one that has next least merit, number it 2, and so on, and send the record to M B Hillegas, Bureau of Education, Washington, D C, or E L Thorndike, Teachers College, Columbia University, New York For this purpose the following slip may be used

I rank specimen 94 as
" " 196
" " 200
" " 300
" " 323
" " 434
" " 519
" " 520
" " 534
" " 627
Signed

94 SULLA AS A TYRANT

When Sulla came back from his conquest Marius had put himself consul so sulla with the army he had with him in his conquest siezed the govern ment from Marius and put himself in consul and had a list of his enemys printy and the men whoes names were on this list we beheaded

196 ICHABOD CRANE

Ichabod Crane was a schoolmaster in a place called Sleepy Hollow He was tall and slim with broad shoulders, long arms that dangled far below his coat sleeves His feet looked as if they might easily have been used for shovels His nose was long and his entire frame was most loosely hung to gether

200

My dear Fred,—

I will tell you of my journey to Delphi Falls, N Y There is nice scenery along this route The prettiest scene is in the gulf which is quite narrow, a small creek flows down it and the road follows along near its banks

There are woods on either side, these trees look very pretty when they are white with snow

In summer it is always shady and cool in them and the small fish may be seen darting back and forth in the water

I hope I will have the pleasure of taking you over the route some time.

Yours sincerely,

300 THE PREACHER OF AUBURN

The most popular man of Auburn was the preacher Although he had a very small salary he was contented The preacher was kind to everybody Little children loved him Old soldiers liked to sit by his fireside and tell stories of the battles, which they had fought in The beggars who came to his door, although chided for leading such an existence, were always clothed and feed

The preacher was always willing to go to the homes where there was sickness or death Here he helped in all things that he could

In the church he preached with unaffected grace, and all who came to scoff at him remained to worship

The minister was a contented, simple and kind man, whom the people loved

323 ESSAY ON BURNS

As far as I can learn from the Essay on Burns, Mr Carlyle considers that good poetry must contain the sincerity of the poet The poem must show the author's good choice of subject and his clearness of sight In order to have good poetry the poet must be familiar with his subject and his poem will show it

The characteristics of a great poet, in Mr Carlyle's opinion were sincerity and choice of subjects A poet must be appreciative of nature and have a responding heart Carlyle says a true poet does no have to write on subjects which are far away and probably come from the clouds A truly great poet makes the most of subjects which are familiar to him and close to earth, as Burns did in his poems to the Field Mouse and to The Daisey

434 A DIARY

I had an early run in the woods before the dew was off the grass The moss was like velvet and as I ran under the arches of yellow and red leaves I sang for joy, my heart was so bright and the world was so beautiful. I stopped at the end of the walk and saw the sunshine out over the wide "Virginia meadows"

It seemed like going through a dark life or grave into heaven beyond A very strange and solemn feeling came over me as I stood there, with no sound but the rustle of the pines, no one near me, and the sun so glorious, as for me alone It seemed as if I felt God as I never did before, and I prayed in my heart that I might keep that happy sense of nearness all my life.

519 DE QUINCY

First De Quinceys mother was a beautiful women and through her De Quincy inhereted much of his genius

His running away from school enfluenced him much as he roamed through the woods, valleys and his mind became very meditative

The greatest enfluence of De Quincy's life was the opium habit If it was not for this habit it is doubtful whether we would now be reading his writings

His companions during his college course and even before that time were great enfluences The surroundings of De Quincy were enfluences Not only De Quincy's habit of opium but other habits which were peculiar to his life

His marriage to the woman which he did not especially care for

The many well educated and noteworthy friends of De Quincy

520 A CHARACTER SKETCH

They were in fact very fine ladies, not deficient in good humour when they were pleased, nor in the power of being agreeable when they chose it, but proud and conceited They were rather handsome, had been educated in one of the first private seminaries in town, had a fortune of twenty thousand pounds, were in the habit of spending more than they ought, and of associating with people of rank, and were therefore in every respect entitled to think well of themselves, and meanly of others

534 FLUELLEN

The passages given show the following characteristic of Fluellen his inclination to brag, his professed knowledge of history, his complaining character, his great patriotism, pride of his leader, admired honesty, revengeful, love of fun and punishment of those who deserve it

627 A SCENE

I think the sunlight is very beautiful on the water, and when it shines on the water it is very beautiful, and I love to watch it when it is so beautiful. The colors are so pretty and the noise of the water with the sunshine are so attractive in the sunshine I wonder do other people love to watch the water like I do. I don't know as there is anything as lovely as the water waves in the sunlight of the glorious orb

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COLUMBIA UNIVERSITY

SEX-LIMITED INHERITANCE AND SEXUAL DIMORPHISM IN POULTRY

WHEN a Barred Rock hen is bred to a non-barred, *e. g.*, black, cock, all the female offspring are non-barred, all the male barred. This generation, then, is sexually dimorphic. The offspring of the reciprocal mating is not dimorphic, since all the offspring are barred. For reasons which will appear in a moment, I wish to repeat the usual formulæ for this case, B standing for barred, b for non-barred, *e. g.*, uniform black.

Barred Rocks: male, B♂ B♂, female, B♂ b♀.
Non barreds: male, b♂ b♂, female, b♂ b♀.
A. Barred females by non barred male gives in F_1,
barred males, B♂ b♂, gametes, B♂ b♂,
and non barred females, b♂ b♀, gametes, b♂ b♀.
Inbred they give in F_2, barred males, B♂ b♂,
non barred males, b♂ b♂,
barred females, B♂ b♀,
non barred females, b♂ b♀.
B. Non barred females by barred male give in F_1,
barred males, B♂ b♂, gametes, B♂ b♂,
and barred females, B♂ b♀, gametes, B♂ b♀.
Inbred they give in F_2, barred males, of two sorts, viz. $\left\{\begin{array}{l}\text{B♂ B♂,}\\ \text{B♂ b♂,}\end{array}\right.$
barred females, B♂ b♀,
non barred females, b♂ b♀.

Now barring is a dominant character. If, however, it is treated as a recessive, *i. e.*, patent only in the homozygous condition, some suggestive results follow. In the first place the Barred Rocks become sexually dimorphic in respect to barring, for the male, being homozygous, will be barred, but the female being heterozygous will be non-barred. Moreover, this dimorphism will continue indefinitely in succeeding generations.

When this hypothetical dimorphic breed is bred reciprocally to a uniform black breed, all the F_1 offspring will be non-barred and the usual signs of sex-limited inheritance will be lacking. The F_2 generation, as shown under A, will all be non-barred, and of those under B only one fourth will be barred and these all males.

This hypothetical case offers a plausible explanation of the mode of inheritance of sexual dimorphism. However, this case, while possible, is probably simpler than any likely to be encountered in actual experience. Moreover, the greater the number of different factors involved, the more the observed ratios will obscure the hypothetical ratios.

The following experiments are interesting in this connection.

First may be recorded the results of crossing Brown Leghorns and Buff Plymouth Rocks. The former's plumage or some of its elements is known to follow a sex-limited mode of inheritance. Of the mating Buff Rock females by Brown Leghorn male only chicks in the down are on hand but they are exactly like the chicks of the reciprocal mating. The adults of this last mating are reddish buff in both sexes without the usual features of sex-limited inheritance. In F_2 true buffs appeared and various other colors (among them the Rhode Island red color) but no true Brown Leghorns. The detailed theoretical formulation must await the results of other matings, but compare under A above. Chicks in the down of the mating F_1 female by Buff Rock male are on hand. None of these, unlike many of the F_1 chicks, are striped. The absence of striped chicks indicates an absence of the heterozygous form.

In the second place are to be recorded the results of castration experiments on young Brown Leghorns. Though not yet old enough to show all the adult characters, the castrated males are assuming the male juvenile plumage, which, it should be noted, is almost as sharply differentiated from the female's juvenile plumage as the adult male's is from the adult female's. The castrated females, on the contrary, have already assumed a considerable part of the male's juvenile plumage.

These experiments indicate that a recessive character, sex limited in inheritance, can, according to the formulæ given above, be utilized in an explanation of the mode of inheritance of sex dimorphism. On the other hand, a dominant sex-limited character, at least in poultry, does not lead in this direction.

While it is probable that the plumage of the male Brown Leghorn is a homozygous recessive, and the female heterozygous, it is

not certain what the dominant element or factor is It may be female Brown Leghorn color, a modifier, or femaleness or something else As females colored nearly like Brown Leghorn females appeared among black females in F_1 from Brown Leghorn males by White Rock females it suggests that the dominant element is not female color

A similar inference may be drawn from the distribution of color in the buff and black nonbarred F_1 females from White or Barred Rock females by Buff Rock male Some of these are black with orange hackle and grade into others in which buff predominates In all cases the colors are distributed in a more or less perfect imitation of the pattern of Brown Leghorn females Moreover, many of these hybrids are stippled in certain regions which always correspond to the regions in Brown Leghorns which are stippled

H D Goodale

"Oakwood,"
Stamford, Conn

THE NORTH CAROLINA ACADEMY OF SCIENCE

The tenth annual meeting of the North Carolina Academy of Science was held at the Agricultural and Mechanical College, Raleigh, on April 28 and 29, 1911, with an attendance of forty members The meeting of the executive committee, held in the early afternoon of April 28, was followed by a general meeting for the reading of papers At night, after the academy had been welcomed to the Agricultural and Mechanical College by President D H Hill, the retiring president of the academy, Professor W H Pegram, delivered his presidential address, "The Problem of the Constitution of Matter" Following this, Professor John F Lanneau gave a lecture on "Sirius. the Bright and Morning Star."

On Saturday morning, April 29, the annual business meeting was had Reports of the secretary-treasurer and of the various committees were made. Five new members were elected These together with the present membership of 80 give a total of 85 members The report of the secretary treasurer showed that the academy in membership, in the interest shown in its work, and in its finances, was in better condition than at any time during its history.

The following officers were elected for the ensuing year

President—H V Wilson, University of North Carolina, Chapel Hill

Vice president—W A Withers, Agricultural and Mechanical College, West Raleigh

Secretary treasurer—E W Gudger, State Normal College, Greensboro

Executive Committee—J J Wolfe, Trinity College, Durham, Franklin Sherman, Jr, Department of Agriculture, Raleigh, Andrew H Patterson, University of North Carolina, Chapel Hill

At 10 A M the academy and the North Carolina Section of the American Chemical Society held a joint meeting at which Dr R A Hall, of the University of North Carolina, read a report on "The Chemical Researches of Ehrlich Leading to '606'" Following this, reading of papers on the academy program was resumed At 2 P M, the program being finished, the academy adjourned to the dining room of the college, where a luncheon was given complimentary to the visiting members

The total attendance was forty out of a membership of eighty five There were thirty three papers on the program, all of which were read save two, and all read when called for but two In attendance, number of papers presented, general interest as evidenced by the discussion of the papers, this session excelled any in the history of the academy In addition to the presidential address, which is published in full in the current number of the *Journal of the Elisha Mitchell Scientific Society*, and to the lecture on Sirius, the following papers were presented

Catching Hawk Moths on Flowers at Dusk C S Brimley, Raleigh

This paper tells the author's experiences in catching hawk moths on flowers at dusk in several years at Raleigh, N C The flowers first experimented with were jimson weed, afterwards four-o'clocks With the jimson weeds it was found that tying the flowers in bunches was an advantage, while this did not apply to the four-o'clocks, as they were already in bunches Two flights of moths were noted, the first in June, the second in July and later, the latter largely, the former wholly composed of moths from over wintering pupæ. The proportion of sexes visiting flowers was 5 males to 2 females. A neighbor's cat was found to be as expert a catcher of hawk moths on flowers as the author The notes apply mainly to the two tobacco hawk moths.

To be published in full in the current number of the *Journal of the Elisha Mitchell Scientific Society*

Natural History Notes E W GUDGER, State Normal College, Greensboro

A *An Interesting Case of Symbiosis* (specimens exhibited) —For six successive seasons, wood frogs, leopard frogs, toads and salamanders (species unknown, probably *Amblystoma punctatum*) have been observed to lay their eggs in a small pool in the college park Each spring it has been noted that the eggs of the salamanders only had a greenish color Microscopic examination shows that this is due to great numbers of a very small unicellular green alga found within the inner mass of jelly The green color grows more marked as the development of the eggs takes place, due presumably to the larger amount of CO_2 given off as the larvæ become more active Since no algæ have ever been found in the outer or general mass of jelly, it seems possible that they may penetrate the oviducts of the salamander and become enclosed in the inner capsule of jelly as the eggs pass to the exterior

B *Some Plant Abnormalities*—A bifurcated frond of the common Boston fern was exhibited This was one of two growing on one plant in the writer's laboratory at the present time Three years ago two others were noticed on different plants

A drawing was exhibited of a motile *Hæmatococcus* with four flagella This was found last fall in a lot of fresh material from a cemetery urn

Conjugating Yeasts W C COKER, University of North Carolina, Chapel Hill

In the course of experiments by an advanced class in the fall of 1910 the rare and peculiar wild yeast, *Schizosaccharomyces octospora* Beyerinck, was found It appeared in test tubes that were filled with distilled water in which were a number of unbroken Delaware grapes that were bought in the local market A day or two after the tubes were prepared a slow fermentation set up, and later a precipitate appeared On examination of this precipitate after three weeks it was found to contain the *Schizosaccharomyces* in process of conjugation A later experiment made with Tokay grapes gave a similar result Cultures were continued and the life history studied in all stages, confirming in general the observations of Guilliermond. Four species of *Schizosaccharomyces* ,are known, all supposed to be tropical or subtropical, and *S octospora* has not been found before in America

Results of a Practical Attempt to Control Lettuce Sclerotiniose F L STEVENS, North Carolina College of Agriculture and Mechanic Arts, West Raleigh

Lettuce sclerotiniose has been the subject of investigation for several years in the North Carolina Agricultural Experiment Station From the laboratory study it was concluded that all structures except the sclerotium are short lived, therefore, that if the formation of new sclerotia could be prevented diseased beds could eventually be restored to health To test this theory several experimental beds were very thoroughly infected in April, 1908, by heavily inoculating a large number of plants and allowing the sclerotia which were formed to remain in the beds The following year 555 plants, or over 45 per cent, died of sclerotiniose From this time on a course of treatment designed to prevent the forming of sclerotia was followed with the hope of lessening the disease The following year only seven plants, or one half of one per cent, of the crop died A year later, that is, the present year, the results were almost the same This experiment seems to indicate that control of this disease can be obtained by the methods employed

Studies in Soil Bacteriology, V—The Nitrifying Powers of North Carolina Soil F L STEVENS and W A WITHERS, assisted by P L GAINEY, F W SHERWOOD and T B STANSEL

During 1909 and 1910 samples were taken from 58 localities representing 21 different soil types, in each of which was a good soil and a poor soil. The soils came from sixteen counties Nitrification was expressed as N E, N I P and N I P in Solu, which terms have been explained in previous publications[1]

A summary of the results is

	N E	N I P	N I P in Solu
Maximum found	105 1	89 9	1 5
Average for good soil	8 7	44 7	0 6
Average for poor soil	5 0	34 8	0 6
Average for all soils	6 8	39 8	0 6

There is seen to be a great difference in results by different methods of testing There is also a difference between the results obtained by the same method on samples taken from the same

[1] *Centralblatt f. Bakt*, Abt II, Bd 25, 1910, p 64

field if the two samples are taken a year apart. N. I. P. in soil gave the higher results on an average, but not always in individual cases, showing that our soil 1931, which has been used so much, affords better conditions for nitrification than most of our soils.

N. I. P. in solution shows no correlation with fertility. N. I. P. in soil shows better nitrification with the good soil in 69.2 per cent. of the pairs. N. E. shows no nitrification in either the good or poor samples in 29.6 per cent. of the pairs, but where there is nitrification it shows better in the good in 63.2 per cent. of the pairs. There are several samples in which the poor soil shows better N. E. and N. I. P. than the good soil.

Some Points on Architectural Acoustics: ANDREW H. PATTERSON, University of North Carolina, Chapel Hill.

An account of experiments made by the author and Mr. A. L. Field on the acoustics of Memorial Hall at the University of North Carolina. The reverberation in this hall is very bad, and the problem is complicated by bad echoes due to large flat panels in the dome-shaped ceiling. Further experiments will be undertaken in an attempt to find a complete solution of the difficulty.

Preliminary Report on the Regeneration of Nemerteans and Amphitrite: JUDSON D. IVES, Wake Forest College, Wake Forest, N. C.

Sections of nemerteans were found to regenerate readily and rapidly. But little new material formed on the anterior surfaces. Small sections, not more than 1.2 cm. long, in twenty-five days regenerated 2.5 cm. on their posterior surfaces. A section, 2.1 cm. long, regenerated 1.5 cm. in twenty-five days. A worm, with its posterior portion cut off, its head and the remaining anterior portion measuring 10.2 cm., regenerated 1 cm. in twenty-nine days.

In Amphitrite, the tentacles regenerate readily. Worms, with the portion in front of the second pair of branchiæ removed, thereby removing the tentacles and the first pair of branchiæ, lived for thirteen days, and were in good condition when killed.

A Dangerous Apple Disease: F. L. STEVENS and GUY WEST WILSON, North Carolina College of Agriculture and Mechanic Arts, West Raleigh.

This disease came to our notice in 1909 from Lincoln County, where it appeared in 1908 on a single tree and despite the cutting out of all disease seen and spraying with lime-sulphur it spread the next year to thirteen trees. The same trouble appeared in Sampson County in 1909 with even more disastrous results.

Whitish or pinkish pustules appear on the younger twigs and about the crotches of the tree. These bear numerous spores of the *Fusarium* or *Tubercularia* type, but so far no ascigerous form has been connected with them. The infection is in the bark, the diseased areas shriveling and separating. The epidermis splits away, exposing the browned surface beneath, or the pustules merely break through the epidermis, especially near the lenticels. Upon older twigs the bark cracks longitudinally, exposing rows of pustules in the cracks. A pinkish mycelial growth sometimes appears on the diseased twigs.

Condimental Feeds, Stock and Poultry Tonics and Conditioners: G. M. MACNIDER, Department of Agriculture, Raleigh.

A review of the work done by the author on proprietary stock and poultry medicines, the results of which have been published in full in a recent bulletin of the North Carolina Department of Agriculture.

Sixty-four preparations were analyzed chemically and microscopically. They were found to be composed largely of a base material such as cotton-seed meal, oil meal, wheat bran, etc., with small amounts of drugs added. Thirty-four drugs were identified in the preparations examined. The ones used in largest amount are practically worthless as medicines, while those that are of value are used in such small amount that they can have no effect.

The Turkey Buzzard Must Go: GEORGE W. LAY, St. Mary's School, Raleigh.

Originally "the birds of the air and the beasts of the field" were the recognized scavengers. The dog even now is so used in oriental countries, but in a higher civilization his services have been superseded by more modern methods.

The turkey buzzard spreads diseases such as chicken pox and hog cholera chiefly by infection carried on the feet. Owing to his great range of flight he carries disease from the point of infection to places far distant. If burial, the proper method for disposal of dead bodies, is used, he becomes a predatory bird, killing chickens, young pigs, etc. He is therefore a dangerous bird and should no longer be protected by law.

To be published in full in the current number of the *Journal of the Elisha Mitchell Scientific Society*.

The Library of Congress as an Aid to Scientific Research E. W. GUDGER

The Library of Congress, with its vast aggregations of books and journals, including the priceless Smithsonian collection, is the greatest aid in America to the historical side of scientific research. Through the system of inter-library loans, nearly any and all of this enormous mass of literature is available to the scientific researcher, provided that his college library bear the cost of transportation. The writer has during the past five years carried on three separate extensive historical researches in ichthyological literature which would have been impossible without access (at a distance) to this great library. It is a pleasure to record the prompt and efficient service with which every one of many requests for books has been met, and to call the attention of scientific men to this great adjunct to their work.

Occurrence of the Yellow Fever Mosquito at Raleigh C. S. BRIMLEY, Raleigh

In the summer of 1910 the writer found a rather small mosquito with white banded legs to be common in his house in the daytime. On investigation this proved to be *Stegomyia calopus*, the species which transmits yellow fever. The species was active all day, biting even at noon in a well lighted room, while mosquitoes taken after dark almost invariably turned out to be other species. The species has not been taken by other Raleigh entomologists. No breeding places were discovered.

Proposed Reform in our Calendar ANDREW H. PATTERSON, University of North Carolina, Chapel Hill

A discussion of the various methods proposed in recent years for the reform in our present calendar.

Some Interesting Water Molds W. C. COKER, University of North Carolina, Chapel Hill

The occurrence in Chapel Hill of *Thraustotheca clavata* (DeBary) Humphrey was reported. It seems to have been found previously only at Strassburg, Germany. In this singular mold the sporangial wall dissolves away almost completely, suggesting the method of spore liberation in *Rhizopus*, and the encysted spores are allowed to fall apart in all directions. The spores escape from their cysts in the laterally ciliated form, showing that the first swimming stage is suppressed.

There also occurs in Chapel Hill a species of *Dictyuchus* in which the entire sporangium breaks away from the hypha as soon as the spores become distinct. After some time the spores escape singly through individual tubes as is normal in the genus. Other points reported were the appearance of a variety of *Achlya americana* with hypogynous tubes, the occurrence in Chapel Hill of *Achlya racemosa* Hildeb., and the fact that *Saprolegnia diclina* Humphrey is at least not always diœcious.

Rhizoctonia of Buckwheat F. L. STEVENS and G. W. WILSON, North Carolina College of Agriculture and Mechanic Arts, West Raleigh

Mention was made of a serious outbreak of rhizoctoniose on buckwheat in the western part of North Carolina.

The Finned-tailed Larva of the Butterfly Ray, Pteroplatea maclura E. W. GUDGER

The adult ray has a very short tail, in length about equal to one third of the body, with very faint traces of dorsal and ventral finfolds. A photograph was exhibited of three young attached to flattened yolks, showing each embryo with a profusion of long external gills and a tail three fourths as long as the body. All three larvæ have the hinder halves of their tails distinctly finned above and below, thus forming broad paddle-like organs. The significance of this in the phylogenetic history of this ray is very great.

More than half the material is at hand for the embryology of the fish, and an effort will be made to collect the remaining stages this season.

The Whistling Arc in the Study of Auditorium Acoustics C. W. EDWARDS, Trinity College, Durham

Employing the well-known device of using a sound-emitting light for a source of sound waves, a whistling arc was used for investigating confusion and distortion in an auditorium. The very large variety of sharp clear notes that the arc could be made to emit by varying the inductance made it especially useful in the study of the less practical problem of distorsion. Small mirrors were used, following the method of F. R. Watson, of the University of Illinois, to trace the path of the sound waves after reflection from various surfaces.

No abstracts have been received for the following papers:

Survivals along the Sea Islands from Hatteras to Key West COLLIER COBB, University of North Carolina, Chapel Hill

The Peat Deposits of North Carolina. JOSEPH H. PRATT, Chapel Hill

Isoetes in North Carolina: W. C. NORTON, North Carolina College of Agriculture and Mechanic Arts, West Raleigh.

The Composition of Melted Kauri Copal, as Used in Varnish Making: CHARLES H. HERTY and C. S. VENABLE, University of North Carolina, Chapel Hill.

Results of some Preliminary Studies in Wing Vein Homologies, Homoptera cicadina (lantern): Z. P. METCALF, Department of Agriculture, Raleigh.

Regressive Differentiation in Hydroids and Sponges: H. V. WILSON, University of North Carolina, Chapel Hill.

A Striking Class-room Experiment after Otto von Guericke (by invitation): J. M. PICKEL, Department of Agriculture, Raleigh.

Recent Changes of Level from Cape Hatteras to Cape Sable (lantern): COLLIER COBB, University of North Carolina, Chapel Hill.

How to Discover the Solution of a Problem: JOHN F. LANNEAU, Wake Forest College, Wake Forest.

Mineralogical Notes on Rutile, Pyrophyllite, Talc and Graphite: J. H. PRATT, Chapel Hill.

Some Interesting Variations in the Flowers of a Local Vinca: W. C. NORTON, North Carolina College of Agriculture and Mechanic Arts, West Raleigh.

Road-surfacing Materials: JOSEPH H. PRATT, Chapel Hill.

Some Seedlings of the Scuppernong Grape (by invitation): F. C. REIMER, Department of Agriculture, Raleigh.

The Postulates of Relativity: C. W. EDWARDS, Trinity College, Durham.

E. W. GUDGER,
Secretary

SOCIETIES AND ACADEMIES

THE AMERICAN PHILOSOPHICAL SOCIETY

AT the meeting of the American Philosophical Society, Philadelphia, on May 5, 1911, an address on lignite was delivered by Dr. Joseph A. Holmes, director, Bureau of Mines, Washington, D. C.

The extent of the lignite deposits in the United States will be realized from the following figures giving the areas in several of the states:

Alabama	6,000
Tennessee	1,000
Louisiana	8,800
Arkansas	5,900
Texas	53,000
South Dakota	4,000
North Dakota	31,000
Montana	7,000

In a number of states in the Rocky Mountain region there are large areas of coal that represents a transition between typical lignites and bituminous coals. For these the name "sub-bituminous coals" has been suggested, and is tentatively used by the United States Geological Survey.

The lignite beds in Alabama, Mississippi and Tennessee represent a transition between peat and the more typical lignites of the Dakotas and Texas. Little or no use has been made of the lignite beds in these three states.

The lignites in Texas and Arkansas have been used to a limited extent, as have also the lignites of the Dakotas and eastern Montana. In this latter field the lignites contain 20, and in some cases more than 40, per cent. moisture, and slack badly and rapidly on exposure to the atmosphere, and this quality seriously interferes with their use and value for fuel purposes.

The outlook for the utilization of lignites is favorable along three lines: (1) In gas producers, without either drying or other treatment; (2) in boilers of special construction, such, for example, as that installed more than a year ago at Williston, N. D., by the United States Reclamation Service, where the lignite is used in its natural condition almost immediately after being brought from the mine; (3) in the form of briquettes. This requires that the lignite should be thoroughly and finely crushed and dried to a moisture content of from five to ten per cent., and then compressed while still warm into briquettes.

Limited quantities of lignite from California, North Dakota and Texas have been made into satisfactory briquettes at the Government Mine Experiment Station at Pittsburgh, using the full-sized German briquetting press, which develops a pressure of twenty to twenty-five thousand pounds per square inch. In the cases just mentioned the briquettes were made without the use of any binding material, a sufficient amount of tarry material remaining in the crushed and dried lignite to serve as a bond to hold the particles together in the briquette.

It is believed that our investigations along this line will demonstrate the fact that the lignite in Texas, and the Dakotas and Montana can be made into briquettes on a commercial scale, and that in this form the lignite can be used as a substitute for other domestic fuel in these regions.

SCIENCE

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MSS. intended for publication and books, etc., intended for review should be sent to the Editor of SCIENCE, Garrison-on-Hudson, N. Y.

NEW REQUIREMENTS FOR ENTRANCE AND GRADUATION AT THE UNIVERSITY OF CHICAGO

THE University of Chicago faculty has just adopted a new plan for entrance to the colleges and a new set of requirements for graduation with the baccalaureate degree, which represent the results of some two years or more of careful study. The original motives for the investigation were several. On the one hand, it was felt that the university was in some essential particulars losing touch with the secondary schools from which its undergraduate student body is recruited. This feeling was not based upon loss of numbers, for these have steadily increased, but in part upon the expressions of the principals and teachers in these schools, and in part upon the considerable number of conditioned students who were received year by year. On the other hand, the faculty has been called upon constantly to consider requests from students to be relieved from certain of the requirements for the bachelor's degrees. The character of these requests made it clear that to some extent at least the curricula of the university were not meeting the reasonable needs of students, nor contributing in the most effective way to their serious education. Too little opportunity was afforded to meet the demands of training for special careers lying outside the usual forms of business and the learned professions. Especially was this maladaptation recognized in the case of women students, for whom it seemed at times desirable to devise special courses of study designed to fit them for particular lines of work. Other matters

might be mentioned which were responsible for the original determination to study the entire situation, but these will suffice to indicate the points of departure As the work progressed it became increasingly evident that nothing short of a drastic reconstruction of the whole principle upon which the requirements of the university were based would adequately meet the necessities of the case

For a number of years past the university has maintained a list of approved schools from which it admits students upon proper certification The test which the schools have been obliged to meet has been that of personal inspection by a competent examining officer This will still be the practise when a school is put upon the list for the first time This is substantially the system in general use throughout the central portions of the country The university proposes now to make a radical departure which involves shifting the emphasis from the examination of the school to a test of its work as judged by the records of its students after they come to the university From this time on carefully tabulated records will be kept, showing the work of each student The authorities of the school from which he comes will be periodically informed of these records and the teaching in the school will be judged accordingly. As an interesting supplement to this plan, it is hoped from time to time to bring teachers from the approved schools to the university to visit those classes which continue the work done in the schools In this way it is expected to bring about a more intelligent cooperation than has hitherto been possible Ordinarily the college inspects the schools We propose, in addition to this, that the schools shall inspect the college. We believe that if this be done in the cordial spirit which has hitherto characterized our relations to the schools, both the university and the schools will be markedly benefited

The university appreciates the vital significance of the development which has been in progress in the high schools of the country during the last decade It sympathizes most cordially with the effort which these schools have been making to furnish, each to its own community, those things most essential to the betterment of the life of that community It recognizes that amid the enormous variety of conditions in American life, schools in different localities, even schools in different portions of the same city, may face obligations in certain essentials widely divergent, to meet which successfully must involve considerable variation in curricula and methods of work The university desires to do nothing which will in any way thwart the fullest success of this tendency in the modern high school The period of sheer dictation by the college to the high school is forever passed Possibly there is at the present time a danger that the schools may, in their turn, attempt to dictate to the college However this may be, the University of Chicago desires and intends to put itself in the position of cooperating in the most effective way with those high schools which are earnestly striving to meet the needs of their communities It desires to leave them the utmost flexibility in the arrangement of their curricula compatible with the carrying forward by the university of solid and serious work, which obviously must have its foundation in the achievements of the school. The college entrance plan shortly to be described has this end as perhaps its most important aim

In compensation for the increased flexibility which the new arrangement permits, the university hereafter will expect to ad-

mit no student with less than fifteen units of entrance credits In other words, entrance with condition is to be abolished

The most striking change in the actual character of the requirements—matters of principle apart—is found in the substitution of certain specifications regarding the *amount* of work which a student must bring to the university as counter-distinguished from the particular subjects in which the credits must be offered The *quality* of the work we expect to test chiefly by the college record of the students Hitherto, following the practise of most colleges, the university has designated so much of this subject, and so much of that, as a requisite for entrance With a single exception, this type of requirement now gives way to a demand for a certain amount of concentrated and continuous work in subjects selected by the student, or by the school, from among the standard academic subjects taught in all high schools The one stipulated subject which must be presented is English, and this is required on the ground of its unique relation to all other subjects in the curriculum

Quoting from the requirements themselves:

Students applying for entrance to the University of Chicago present by certificate from approved schools, or by examination, 15 units of entrance credits. Among these must be 3 units of English and in addition one principal group of 3 or more units, and at least one secondary group of 2 or more units These additional groups may be selected from among the following subjects

1 Ancient languages (Greek and Latin), it being understood that to make a group of 2 or of 3 units the work must be offered in a single language

2. Modern languages other than English, to make a group of 2 or of 3 units work must be offered in a single language as under group one.

3. Ancient history, medieval and modern history, English history, United States history, civics, economics.

4. Mathematics.

5 Physics, chemistry, botany, zoology, general biology, physiology, physiography, general astronomy

Not less than 1 unit may be offered in either physics or chemistry Any combination of the subjects within each group is permitted

Of the 15 units offered for entrance not less than 7 must be chosen from subjects in groups 1–5 (or 10 including English) Not less than one half unit may be offered in any subject

The remaining 5 units may be selected from any subjects for which credit toward graduation is given by the approved school from which the student receives his diploma, but Greek, Latin, French, German (and all modern languages other than English), mathematics, physics and chemistry, if offered, but not as above under 1 and 5, must each consist of at least 1 unit Latin may not be continued in college unless at least 2 units be offered

It will be noted that a student may be admitted without having taken any work in three of the groups, provided he has had enough work in the other two, and that the content of 5 units is left entirely to the secondary schools, the only restriction being that they accredit the work toward their own diploma The university is confident that such freedom in admission will in no way impair the standard of its degrees, because for several years a rigid method of grading has been in force, by which inefficient students are inevitably eliminated very early in the course

The first two years of the college course are designed to articulate in the most intimate way with the high school course, and to assure certain results by the end of the second year of college residence, such as may enable the student at, or before that time, to enter with the greatest advantage upon professional specialization of one kind or another, and to make certain that each student, whether consciously aiming at a particular vocation or not, shall before graduation have acquired a reasonable mastery of one or more fields of knowledge.

To secure an effective correlation of

the high school and the college work it is provided that throughout the first year of his college residence the student shall pursue one subject which he has pursued in the high school either for two or for three years, or which he has pursued throughout the whole of the final year of his school course. The student will be encouraged to choose the last alternative only in cases where it is fairly certain that this subject is to constitute one of the important lines of specialization in his college work. Were either of the first two alternatives adopted, which would perhaps most often occur, the result would be to assure by the end of the first year a considerable proficiency in some one subject. It will be remembered that the entrance requirements were designed primarily to assure the gaining of a satisfactory amount of concentration in some two or more lines of work without particular reference to the special subjects in which such concentration was demanded. The requirement just described for the first year of college is intended to carry forward this principle of concentration, and to secure the two-fold result of bridging the gap between the college and the high school in a subject with which the student is already reasonably familiar, and also to secure at a relatively early stage of the college course the intellectual advantages which are gained by a considerable mastery of some one topic.

The college requirements fall into two main groups, those which are to be fulfilled during the first two years of the course, and those which are to be fulfilled before graduation, and chiefly during the final two years of residence. For a number of years the university has conferred a title known as the associate's title upon students who have completed with a certain degree of excellence the first two years of the college course. This title will still be conferred in accordance with the following plan.

In conjunction with the requirements for the "continuation work" in the first year are those now to be described which extend over the first and second years. During this period two courses in English and one in public speaking must be taken. The student is also obligated so to arrange his work that either in the high school or in the first two years of college he shall have completed the equivalent of two units in each of the following four groups of subjects: (1) Philosophy, history, social science, (2) modern language other than English, (3) mathematics, (4) science, physical or biological.

The English requirement is simply a continuation of the one which the university has administered for a number of years, and which experience apparently justifies. It is designed primarily to equip the student with a satisfactory command over the written and the spoken form of his mother tongue.

The distributive "group" requirement is obviously designed to assure the possession by each student of at least a rudimentary acquaintance with each of the great typical fields of knowledge. It will be readily understood by those familiar with high school curricula, that a student in a well equipped school might easily fulfill this group requirement before entering college. If this be not done, however, the discrepancy must then be made good before the end of the second college year.

The requirement in modern language is intended to assure the student a practical reading knowledge of some one modern language. This capacity will be tested by suitable examinations in the case of students who enter the university with credits for the required amount of language; or the successful passing of an advanced

course with a standard of excellence distinctly above the passing mark will be regarded as satisfying the requirement

In general, then, it is intended that by the end of the second college year the student shall have secured a reasonable mastery over some one field of the work which he brings in from the high school, that he shall have come in contact with all the main divisions of knowledge, and that he shall be in possession, for purposes of practical use in his work, of at least one of the modern languages other than English.

Requirements for the bachelor's degree, in addition to those for the associate's title, involve the completion by the student of a principal and a secondary sequence of coherent and progressive courses The principal sequence must consist of nine such courses, each occupying either 48 or 60 hours of class work [double this amount in the case of laboratory courses] The secondary sequence must contain six such courses in another subject It will be understood that the student is obliged to present a full four years of work at a certain standard grade It may also be added that should a student decide to choose one of his sequences in the subject which he pursued as a continuation course in his first year, the three courses taken at that time may be included in the total number required to make up the sequence. This requirement is intended to secure a high degree of specialization in at least one subject of the university curriculum, with a lesser degree of concentration in some secondary topic, which might often be distinctly supplementary to the first The university has for a number of years had a nine major requirement for its S.B degree, and its experience with this plan affords a high measure of confidence that the new proposals will prove extremely efficient in obtaining substantial results

Under normal circumstances, students will be left slightly less than one third of their courses in high school and in college open to free election The more judiciously the school course were arranged, the larger would be the number of free electives in college Ordinarily not more than fifteen full courses may be taken in college in any one department

When the principal sequence is taken in the department of science the S B degree is conferred When it is in the modern languages or the social and historical sciences, or in philosophy, the Ph B degree is conferred The A B degree is conferred when the two sequences are respectively in Latin and Greek In this case the exact amount required varies somewhat from the other instances, and the requirement must be in part fulfilled in the preparatory school The general plan, however, is exactly the same as in the case of the other degrees, and the detailed provisions need not be explained in this place The university has conferred these three degrees for a number of years

A large number of alternative sequences will be worked out, designed to meet in the most effective way a variety of student needs Students contemplating a professional career in law or in medicine will have sequences offered to them prepared with special reference to these professions The same thing will be done for students whose needs are of a different character It is also contemplated that any student who is able to present to his dean at an early stage in his college work sequences of an educationally defensible kind, other than those prepared by the faculty, may, upon securing permission from the college board, be allowed to pursue such courses It is hoped that in this

way adequate provision may be made for the larger vocational interests represented by college students of serious purpose and well matured plans. An inspection of the provisions will at once make clear that the conception of vocational training is broad and catholic, and not in any way to be identified with the occasionally narrow and shallow training afforded by so-called vocational schools.

JAMES ROWLAND ANGELL
THE UNIVERSITY OF CHICAGO

THE MAN OF SCIENCE AND HIS DUTIES[1]

I HAVE been laboring with some uncertainty, in an effort to determine what would be most suitable for an occasion of this kind. Shall I read a text, or shall I sound a key-note? Perhaps either or both would be in harmony with the occasion. For it is the aim of this society to promote what I consider the highest interests of mankind. We are to give every possible encouragement to those who seek to widen the boundaries of human knowledge. The world is beginning to learn how all-important it is that this should be done. We no longer need to spend any time in contending for such ideas. We only need to ask the doubter to read history, and to open his eyes to his surroundings. The boundary of human knowledge has been widening in a way that must excite our wonder. Like the four sages, of whom Dante has given us a beautiful picture, we stand in the hemisphere of light that has been kindled in our midst, and which slowly pushes back the surrounding darkness. But this only serves to reveal, more and more, the immensity of the region of darkness which still lies beyond. I wish to emphasize on every proper occasion, and certainly on this occasion, that the men who have earned and deserve the peculiar and special gratitude of their successors, are the men who could by no means foresee the value of their work.

Think for a moment of what the world owes to Michael Faraday. He never suspected the value of his work. The most learned men of his day were interested in his results, but they could not foresee their value. He was a man who had none of the advantages which a college student of to-day so often neglects. The son of a blacksmith, he was apprenticed to a bookbinder. While at this labor, he attracted the attention of Sir Humphry Davy, who was in charge of the laboratories of the Royal Institution. And this institution, by the way, was founded by a former teacher in a New England school, who became Count Rumford, and who was one of the greatest men that America has produced.

Faraday became the assistant of Davy, and he remained in the institution for fifty-four years. At the age of forty-two his merits were recognized by the governing board, in an action which relieved him of all lecture and instruction work. This was also a recognition of an obligation which they owed to the world.

Consider the results of one fragment of his work. On September 22, 1831, two years before he was relieved of instruction duties, Faraday wrote in his note-book as follows:

> I have had an iron ring made (soft iron), iron round and ⅞ of an inch thick, and ring six inches in external diameter. Wound many coils of copper round one half of the ring, being separated by twine and calico. There were three lengths of wire, each about 24 feet long, and they could be connected as one length or as separate lengths. By trial with a trough, each was insulated from the other. We will call this side of the ring *A*. On the other side, but separated by an interval, was wound wire in two pieces, together amounting

[1] Address of the president of Washington Chapter Sigma Xi.

to about 60 ft in length, the direction being as with the other coils This side call *B*

Charged a battery of ten plates, four inches square, made the coil on *B* side one coil, and connected its extremities by a copper wire passing to a distance and just over a magnetic needle (three feet from iron ring) Then connected the ends on one of the pieces on *A* side with the battery immediately a sensible effect on needle It oscillated, and settled at last in original position On breaking connection of *A* side with the battery, again a disturbance of the needle

Later he varied the experiment and writes:

In place of the indicating helix, our galvanometer was used, and then a sudden jerk was perceived when battery communication was *made* and *broken*, but it was so slight as to be scarcely visible It was one way when made and the other way when broken, and the needle took up its natural position at intermediate times

The device which Faraday described was a transformer The impulses which he saw in the needle were due to induced currents He was at once led by this to the invention of the first dynamo, which he constructed during the same month

If any person had asked Faraday that exasperating question, what is all this worth in pounds, shillings and pence, or what are your services really worth per student hour, he would have been utterly unable to make a satisfactory reply The effects were so minute that it was with difficulty that they could be seen The forces involved were utterly insignificant His dynamo was worthless as a machine Who could then have imagined that these feeble impulses would some day be pumped through wires to light large cities, and to move heavy cars loaded down with passengers? Who could have then believed that articulate speech would ever be transmitted by them? Who could then have believed that ships on the ocean would some day be in constant communication with the land, by means of such impulses transmitted through space, and that a ship in distress would thus be able to call for help? Had any prophet foretold all of this at that time, it would have been called the idle fancy of a foolish brain And yet all of these great things followed directly from those simple experiments

And the end is not yet We are beginning to see the importance of saving our fuel We may be able to grow trees, but we can not grow coal An age of water power is before us when vast amounts of power will be thus obtained, and transmitted, by these methods devised by Faraday, to distant cities Millions upon millions of dollars are now invested, and vast armies of men are employed in enterprises which followed directly from these simple experiments

When Helmholtz visited London in 1853 he wrote to his wife an account of his visit to Faraday, in which he says

Those were splendid moments He is as simple, charming and unaffected as a child, I have never seen a man with such winning ways He was, moreover, extremely kind, and showed me all there was to see That indeed was little enough—for a few wires and some old bits of wood and iron seem to serve him for the greatest discoveries

It is often said that work of such character is not for all, that only a few of the elect are capable of doing it In a sense this is true There are comparatively few who will in their younger days submit to the agonizing struggle through which one must go, in order that he may gain control of his mental faculties If he is mentally slow in his sense perception, it will be necessary for him to engage, persistently, for hours, days and years, in a mental struggle with problems which tax his utmost powers It is in this way that one finally acquires the capacity for careful and logical and persistent thinking. It goes without saying that there are comparatively few who will submit to such an

initiation. Certainly the average man is not and never has been of that class Such men are thinking men In their younger days most men are disposed to criticize the work of others Among men of science this is much less common than it was thirty or forty years ago Every one who has ever accomplished anything will recognize the truth of Goethe's remark

> It is easier to recognize error than to find truth That lies upon the surface so that it is easily dealt with, this rests in the depths, to search for which is not every man's affair

As one's powers develop and he begins to attack constructive work, and to make mistakes, he begins to take less interest in searching for errors in the work of others To search for truth is any man's affair who chooses to do so And history tells us in no uncertain way that human development has always resulted from the efforts of those who have expended most of their energy in independent thinking Sometimes the world has followed slowly. Sometimes the results have only become apparent in succeeding generations. Our industrial development has, however, always followed in the pathways marked out by scientific men Their work has always preceded the work of the engineer and the inventor And in the words of my text, When any nation has reached such a stage in its existence, that scientific discovery is put into the background as of no practical value, and the entire current of work is expended in engineering and business activity, that nation is on the way to the civilization of China.

As a nation we have before us problems that are vastly greater than any which have been solved in the past. We may assume that the future will take care of itself We may assume that our leaders in thought and in knowledge will always be with us. We should, however, remember, that there have been former civilizations in other lands, of which no trace can now be obtained, without digging below the surface of the earth.

The question which should now interest us is, whether or not our civilization is to have such an ending

It is only a century ago since one of my ancestors moved with his family from Vermont to the far west There were few roads amid the immense forests through which they wandered, and in the midst of which the family finally found a home in central New York. I personally knew, and still remember the names of some of the men who developed that country What they did was to chop down forests and burn them. What they then did should now be called by another name

There are now among us men who are ambitious to waste the resources of the country, on the plea that they are developing those resources They protest strongly against the importation of lumber from Canada, because it would interfere with the chopping down of our own trees Fifty years ago there was not a locomotive engine in the country which was operated by coal fires They were all operated by wood fires The locomotive of to-day could not be operated by wood fires, and the wood is no longer available. Then a 100-ton locomotive would have been considered an impossibility The bridges of that day would not have sustained them. At that time a 30-ton locomotive was in general use Now we have locomotives which approach 300 tons. Thirty years ago the idea that 1,000 horse-power engines would be used for developing power to be distributed by electrical means was ridiculed as absurd by electrical authorities.

Even if we take the most liberal estimate of the amount of available coal yet unburned, and consider the enormous in-

crease in its consumption, we must still admit that the burning of coal is a mere incident in human history It seems to me that it is the duty of thinking people to begin to think about such things Why should they be left to those who are continually planning to perfect and legalize schemes of public robbery? The people of the country are waiting for leaders, who have been trained in methods of careful and logical thinking, who not only are not for sale, but who can not be bought and who are not afraid

There are other duties which are demanded of thinking men It is evident that the honest public needs light on many questions which are of vital interest to all. It is possible to fool nearly half of the people, nearly all of the time For example, there are many well-meaning people to whom it would never occur that the citizens of Missouri need protection against Iowa, or Arkansas, who can be made to believe that the people of the United States need protection against Canada, or Germany or England.

What we do need protection against, first of all, is organized systems of bribery and public robbery

I know of men who have given attention to such public matters, who have engaged in a successful private business, and who among a wholly different class of men are regarded as authorities in some branch of scholarly or scientific work The man who has scholarly tastes, the man who appreciates the value of those things which money can not buy, is not likely to be dominated by the insane greed which seems to have taken possession of such a large class of our citizens. He may appreciate the approval and gratitude of those whom he has helped, and to whom his life has been an inspiration. He is not dominated by a desire to attract attention Certainly he will not seek to attract attention by spectacular or ostentatious waste of ill-gotten gains.

Perhaps we should not be far from the truth if we lay down as a fundamental axiom, that men's lives are guided by a desire to secure personal enjoyment or pleasure The differences between men arise when we observe from their behavior, what it is that gives pleasure to them. Some will undergo hardships and distress, for the joy of attaining a worthy end Some will spend their earnings for the pleasure of a midnight carouse The searcher for the unknown in nature will spend years of labor and mental toil, in the hope that he may feel the joy of finally adding his mite to the store of knowledge which his predecessors have given to the world Such work as this is often attended with a feeling which might properly be called mental distress

In the twenty-fourth series of his "Experimental Researches" Faraday describes many tedious and intricate experiments in which he sought to discover some relation between electrical action and gravitation As his biographer tells us, "He labored with characteristic energy for days, on the clock-tower of the Houses of Parliament and in the shot-tower of Southward, raising and lowering heavy weights connected with wire coils" Many times his results appeared for a time to furnish conclusive proof of his assumption. Then came a period of self criticism, and of doubt, and when the final end was reached, there remained absolutely no result As Faraday described his mental condition, "Occasionally, and frequently, the exercise of the judgment ought to end in absolute reservation We are not infallible, and so we ought to be cautious." On another occasion he said:

The world little knows how many of the thoughts and theories which have passed through the mind of the scientific investigator, have been crushed in silence and secrecy by his own severe criticism and adverse examination, that in the most successful instances, not a tenth of the suggestions, the hopes, the wishes, the preliminary conclusions have been realized

It is a matter of common observation that men who have done most to widen the boundaries of human knowledge, are the ones who are most frequently in a state of doubt They are always ready to take the whole matter into consideration again when some preliminary conclusion is confronted with conflicting evidence In physics where we seek the relation between various values which are simultaneously involved in some function, as in the bending of a beam under a load, we can vary one quantity only, and find its effect on the result When this has been done with all of the variables which are concerned, the entire equation involving the simultaneous effect of all the variables can be written When we undertake to determine the effect upon a nation, of some national policy, we are never able to control conditions in two successive experiments We can not eliminate the disturbing effect of other influences or conditions which have also changed and which are of importance in determining the result But the political orator is never in doubt He speaks with as much of assurance as a lawyer, who argues a case in court

It is not the duty of a scientific man to defend what is generally believed to be the truth The mental attitude of the advocate is foreign to every instinct that the man of science should possess In Galileo's time we can well understand how the man of science should actively contend in quarrelsome debate with those who refused to look through his telescope It was enough for them to know that there were seven openings in the head, seven metals, and seven days in the week This was proof enough that there could only be seven planetary bodies The moon and the sun were perfect as they came from the hand of the creator This was proof enough that there could be no mountains and valleys on the moon, and no spots on the sun It needs no telescope to settle such questions That all bodies do not fall with the same acceleration has been already passed upon in a prior decision It is sufficient to cite that opinion, and Galileo's experiment at the tower of Pisa counts for nothing

Galileo was himself a product of an age characterized by ideas of this kind. In his day his mental attitude was perhaps needful There are times when the soil must be plowed In our time the man of science is free to go his own way in the pursuit of his work and in publishing it to the world If one feels dissatisfied with the present, he can do nothing better than to read history.

I have often felt that scientific students of our time would be greatly benefited by reading much more of history than is their custom There are some most interesting remnants of scientific history, connected with the Moorish occupation of Spain The work of Alhazen, who lived about 1100 A D would have been creditable in any age It requires great patience for one living in this age to read European history during the times of Luther and Galileo. It is, however, only in this way that we can realize what progress the world has been making

It is, however, a satisfaction to know that nations have never been driven to bloody wars in order to enforce the doctrine of universal gravitation, or Kepler's third law, or the doctrine of evolution.

We do learn that in those earlier times,

a public official who would dare to interfere with princely schemes of public robbery, would generally lose his head Now he at most loses his position Our merchant princes are not so severe as their predecessors were

The barber of the present day is not expected to do surgical work, although his sign still gives notice that accidents may happen The bloody pole with its white bandage reminds us of the days when the barber was the surgeon The family of Poisson decided for him in his youthful days that the work of a notary required greater intelligence than he possessed, and advised him to become a surgeon It was not until 1745 that the "barberous" work of the surgeon and the surgical work of the barber were, in England, eliminated by law

Not only should one study the history of the arts and sciences, but even more inspiring are the biographies of the great men of history Most of the men who have given direction to scientific thought and work have been men who came from the most humble positions in life. Occasionally we find one coming from so-called higher levels, who was not satisfied to be simply a descendant. To read an account of the work of such men, in connection with the human element which enters into a biography, often opens up a new world to a young man He may thus learn that he possesses elements which respond to such history. It is not saying too much to say that the great mass of students in college never come into contact with the great things of the learned world They do not do enough of skirmishing in the fields of learning They waste their time in trivial matters which will have little value to them in the future They perhaps never acquire the faintest knowledge of branches of learning, which, if they knew of them, would change the whole current of their lives

And in order that one may do new work it is not necessary to hunt for new fields Remember that the Crookes tube was in physical laboratories in all parts of the world for seventeen years, before any one suspected that it was an X-ray tube Rontgen was hunting for accidents of the kind, and he accidentally discovered that there were phenomena outside of the tube that demanded attention It is only needful that one shall read and think, and the work of others, which may have been published half a century ago, will suggest something to you which it never suggested to any one before, and which may occupy your attention for years

FRANCIS E NIPHER

BRITISH VITAL STATISTICS

THE British Registrar-General has issued his return relating to the births and deaths in the first quarter of the year, and to the marriages during the three months ending December last From the abstract in *The British Medical Journal* it appears that the marriage-rate during that period was equal to 16 1 per 1,000, or 0 7 per 1,000 less than the average rate for the corresponding quarter in the ten preceding years

The 223,588 births registered in England and Wales during the quarter under notice were equal to an annual rate of 24 8 per 1,000 of the estimated population, the birth-rate last quarter was 2 7 per 1,000 below the average rate for the corresponding period of the ten preceding years, and is the lowest birth-rate recorded in the first quarter of any year since the establishment of civil registration. Among the several counties the birth-rates ranged from 17 8 in Carnarvonshire, 18 5 in Sussex, 19 6 in Northamptonshire, 20.1 in Kent, and 20 6 in Dorsetshire and in Gloucestershire, to 29.1 in Nottinghamshire, 31.3 in Carmarthenshire, 31 4 in Durham, 34 5 in Glamorganshire and 35 9 in Mon-

mouthshire. In seventy-seven of the largest towns, including London, the birth-rate averaged 24.9 per 1,000, in London the rate was 23.9, while among the other towns it ranged from 14.5 in Hastings, 15.1 in Hornsey, 16.0 in Bournemouth, 16.7 in Halifax, and 18.3 in Handsworth (Staffs), to 31.5 in Merthyr Tydfil, 33.6 in St. Helens, 35.3 in Coventry, 35.9 in Swansea, and 41.8 in Rhondda.

The excess of births over deaths during the quarter was 80,447, against 83,784, 68,281, and 85,256 in the corresponding quarters of the three preceding years. From a return issued by the Board of Trade it appears that the passenger movement between the United Kingdom and places outside Europe resulted in a net balance outward of 70,973 persons. There was an outward balance of 46,076 English passengers, 1,185 Welsh, 11,473 Scottish, 4,002 Irish, and of 8,812 foreigners, while there was an inward balance of 575 British Colonial passengers.

During the three months under notice the deaths of 143,141 persons were registered, equal to an annual rate of 15.9 per 1,000, or 1.7 per 1,000 less than the average rate for the corresponding quarter in the ten preceding years. The lowest county death-rates last quarter were 13.3 in Middlesex and in Essex, 13.5 in Kent, 13.6 in Leicestershire, 13.7 in Northamptonshire, and 13.9 in Worcestershire, the highest rates were 18.2 in Herefordshire, 18.5 in Devonshire, 19.0 in Monmouthshire, 19.6 in the North Riding of Yorkshire, and 20.2 in Carmarthenshire. In seventy-seven of the largest towns the corrected death-rate averaged 16.8 per 1,000; in 136 smaller towns the rate was 15.4 per 1,000, which was also the rate in the remainder of the country. The crude death-rates in the seventy-seven towns ranged from 7.6 in King's Norton, 8.5 in Hornsey and in Handsworth (Staffs), and 10.4 in East Ham, to 19.2 in Oldham, 19.3 in Dewsbury and in Swansea, 19.4 in Liverpool, 20.0 in Sheffield, 20.7 in Coventry, and 23.1 in Middlesbrough; in London the death-rate was 15.8 per 1,000.

The 143,141 deaths from all causes last quarter included 12,535 which were referred to the principal infectious diseases, of these, 6,147 were attributed to measles, 2,631 to whooping-cough, 1,439 to diarrhœa and enteritis (among children under two years of age), 1,369 to diphtheria, 515 to scarlet fever, 421 to enteric fever, 9 to small-pox, 2 to typhus, and 2 to pyrexia of uncertain origin.

The rate of infant mortality, measured by the proportion of deaths among children under one year of age to registered births, was equal to 115 per 1,000 or 15 per 1,000 less than the average rate in the ten preceding first quarters. Among the several counties the rates of infant mortality last quarter ranged from 88 in Sussex, 91 in Surrey, 93 in Dorsetshire, 94 in Hampshire and in Buckinghamshire, and 95 in Hertfordshire, to 130 in Cornwall, 138 in Cumberland, 144 in the North Riding of Yorkshire, 145 in Monmouthshire, and 164 in Carmarthenshire. In seventy-seven of the largest towns the rate averaged 115 per 1,000 (being equal to the rate in the country as a whole), and ranged from 57 in Hornsey, 65 in Wallasey, 79 in King's Norton and 80 in Hastings and in Great Yarmouth, to 149 in Sheffield and in Rotherham, 151 in Grimsby, 158 in Blackburn, 165 in Dewsbury and 186 in Middlesbrough.

The death-rate among persons aged 1 to 65 years was 8.7 per 1,000 of the population estimated to be living at those ages. In the seventy-seven large towns the death-rate in this age-group averaged 9.4 per 1,000, and ranged from 3.5 in King's Norton, 4.1 in Hornsey, 4.2 in Handsworth (Staffs), 5.8 in Ipswich, 6.2 in Leicester, and 6.3 in Bournemouth, to 12.2 in Oldham, 12.3 in Coventry and in Liverpool, 13.4 in Sheffield and 15.1 in Middlesbrough.

Among persons aged 65 years and upwards the rate of mortality last quarter was 104.6 per 1,000; in the seventy-seven towns the death-rate in this age-group averaged 111.9 per 1,000, the lowest rates being 69.0 in King's Norton, 76.5 in Handsworth (Staffs), 85.8 in West Bromwich and 87.0 in Norwich and in Devonport; and the highest rates, 140.0 in Swansea, 142.0 in Huddersfield, 144.2 in

Dewsbury, 155.4 in Burnley and 158.5 in Bootle.

The mean temperature of the air last quarter was above the average in most districts, the total amount of rainfall was less than the average, and, owing to the general dullness in March, there was a deficiency in the total duration of bright sunshine during the quarter.

APPROPRIATIONS FOR THE UNIVERSITY OF ILLINOIS

THE forty-seventh general assembly of the state of Illinois, which closed its regular session on June 1, by a record breaking act, has distinguished itself in the cause of state education. Former legislatures of the state had made what was considered at the time generous appropriations for the state university. The present General Assembly, however, recognized the ever-increasing needs of the state university and its great public service by appropriating for its support for the coming biennium the sum of $3,519,300. This is the largest appropriation ever made by a state legislature to a state educational institution and a million and a quarter larger than the largest appropriation ever before made to the University of Illinois.

But this is not all. The present general assembly not only recognized the immediate needs of the university and provided for them, but it had the courage to look ahead and make wise provision for the future by levying a one mill tax for its continued support. It is estimated that this tax will yield an income to the university, two years hence, of about two and one quarter million dollars a year. Thus the legislature has crowned its important work for state education by providing what is in effect a permanent annual grant equal to the income at 5 per cent. of an endowment fund of $45,000,000.

By these acts the general assembly eloquently expresses its confidence in the management of university affairs and its general approval of the able leadership and restless energy of the university's president, Dr. Edmund J. James.

The extent and nature of the work of the university for which the legislature has made appropriations will be seen from the following items:

		For the Biennium 1911-1913
For salaries and operating expenses		$1,150,000
Books for the library		50,000
Maintenance of the College of Engineering and Engineering Experiment Station (not including building)		180,000
For the College of Agriculture and Agricultural Experiment Station (not including buildings)		799,300
For Social and Political Science		50,000
Support of Law School		50,000
Support of Graduate School		100,000
Support of College of Medicine		120,000
Maintenance and equipment of Mining Engineering		55,000
Support of ceramics		30,000
For new buildings		724,000
Armory	$100,000	
Engineering building and ground	200,000	
Building for School of Commerce	125,000	
Addition to Woman's building	125,000	
For Kiln House for Ceramics	21,000	
For agricultural buildings	153,000	
For purchase of land, Agricultural Experiment Station		20,000
Other items not included above		191,000
Total		$3,519,300

In addition to the above the university will receive from the federal government and other sources funds that will bring its income to about $2,000,000 per annum for the next biennium beginning July 1, 1910.

Of the above appropriations there is one item that should be noticed particularly as it is the first appropriation ever made by the state of Illinois for the purpose specified. It is the item of $60,000 per year for the support of the College of Medicine of the university. By this act the state of Illinois takes its place among modern states in recognizing its high duty to take measures for the protection of the health of its citizens.

No account has been taken in the above items of the appropriations made for the State Laboratory of Natural History, for the State Entomologist's Office, for the State Geological Survey and the State Water Survey, whose activities are closely allied with the work of the university

B E POWELL

SCIENTIFIC NOTES AND NEWS

THE University of Gottingen has conferred the honorary degree of doctor of philosophy upon Professor Albert A Michelson, head of the department of physics at the University of Chicago, and retiring president of the American Association for the Advancement of Science

THE George Washington University has conferred the honorary degree of doctor of medicine on Dr L O Howard, chief of the Bureau of Entomology and permanent secretary of the American Association for the Advancement of Science, for "distinguished services to science in relation to preventive medicine"

CAMBRIDGE UNIVERSITY has conferred its doctorate of science on Dr George E Hale, director of the Solar Observatory of Mt Wilson, and on Dr T W Richards, of Harvard University

DR ALLEN J SMITH, dean of the Medical School of the University of Pennsylvania, received the degree of LL D at the exercises attending the opening of the Medical School Building of McGill University

SURGEON-GENERAL CHARLES F STOKES, U S. Navy, delivered the valedictory address at the commencement exercises of Jefferson Medical College, Philadelphia, on June 5 On this occasion the college conferred on him the degree of LL D and on the following day Columbia University, from which he graduated in medicine, gave him the degree of D Sc

UNDER the auspices of the president and council of the Chemical Society, the Faraday lecture was delivered in London on June 14 by Professor Theodore W. Richards, of Harvard University. At the conclusion of the lecture the Faraday medal was presented to Professor Richards

DR W M DAVIS, Sturgis-Hooper professor of geology at Harvard University, has been appointed visiting professor at Paris under the new arrangement between Harvard and the Ministry of Public Instruction

AT the annual meeting of the London Institution of Electrical Engineers, Mr. S Z de Ferranti was elected president

PROFESSOR POHL, of Prague, has been appointed director of the institute of pharmacology at Breslau in place of Professor Filehne

THERE have retired from active service Dr Rudolf Nietzki, professor of chemistry at Bâsle, Dr Louis Isely, professor of mathematics at Neuchâtel, and Dr Bernhard Tollens, associate professor of agricultural chemistry at Gottingen

PROFESSOR CHAS W HARGITT, of Syracuse University, has recently returned from a seven-months' sojourn in Europe as a part of his sabbatic year After brief visits to the laboratories at Plymouth, London University, Munich, Vienna and Paris, four months were spent at the Naples Zoological Station, occupying the Smithsonian table Several American laboratories have also been visited

PROFESSOR BURTON E LIVINGSTON, of the Johns Hopkins University, will continue his researches at the Desert Laboratory, Tucson, Ariz, during the present summer He will be assisted by Professor J S Caldwell, of the University of Nashville

MR FREDERICK G CLAPP has been investigating the geological occurrence of petroleum in the Mexican oil fields

THE first two incumbents of the Kahn traveling fellowships for American teachers are Professor John H T. McPherson, professor of history and political science in the University of Georgia, Athens, Ga, and Professor Francis Daniels, professor of romance languages in Wabash College, Crawfordsville, Ind.

ON May 29 Professor Herbert N. McCoy, of the University of Chicago, delivered the

annual lecture before the Northwestern Chapter of Sigma Xi on the subject "Radioactivity and the Nature of Matter"

ACCORDING to *Nature* a festival in memory of Richard Jefferies was held at Swindon on Saturday, June 10 Jefferies was born at Coate, near Swindon, and spent his early life in the latter place A visit to Coate Farm, the naturalist's birthplace, and an open-air concert, morris dancing, speeches and a short service in Chiseldon Church were arranged

DR EMMA WILSON DAVIDSON MOOERS, custodian of the neuropathological collection of the Harvard Medical School, whose death we announced last week, died of streptococcus septicemia and meningitis The infection was contracted by contact with a brain from a subject dying in the recent tonsilitis epidemic of Cambridge, Mass Dr Southard, who removed the brain at autopsy, escaped with merely a septic hand

ISAIAH FAWKES EVERHART, M D, naturalist and philanthropist, died at Scranton, Pa, on May 26, 1911, aged 71 years Dr Everhart was the founder and endower of the Everhart Museum of Natural History, Science and Art A bronze statue of Dr Everhart, presented by Dr B H Warren, of West Chester, has been erected in front of the museum at Scranton, and preparations were being made for its unveiling

DR. CARL BECK, president and surgeon of St Mark's Hospital and professor of surgery in the New York Post-graduate Medical School, has died at the age of fifty-four years

DR. ALEXANDER BRUCE, known for his contributions to neurology and diseases of the nervous system, has died at the age of fifty-six years.

DR. LUDWIG KERSCHNER, professor of histology and embryology at Innsbruck, has died at the age of fifty-two years

THE U. S. Civil Service Commission announces the postponement to July 5, of the examination announced to be held on May 24, to fill the position of soil bibliographer, Bureau of Soils, Department of Agriculture, at a salary of $1,400 per annum

BARON ALBERT VON ROTHSCHILD, of Vienna, has bequeathed $40,000 to establish a prize in astronomy.

Nature states that the sum of £1,000 has been placed at the disposal of the British home secretary by a colliery proprietor to form a prize for the best and safest electric lamp for use in mines, and Messrs C Rhodes and C H Merz have consented to act as judges upon the lamps submitted The competing lamps must be addressed care of Mr C Rhodes at the Home Office Testing Station, Rotherham, and must be delivered by December 31 next

THE *Journal* of the American Medical Association states that the scientific laboratories on Monte Rosa, named after the late Professor A Mosso, of Turin, will be opened for scientific research on and after July 15 There are sections devoted to physiology, botany, physics and microbacteriology, and there are nineteen posts open to research workers from the countries or institutions which contribute to the support of the institution Applications for reservation of a place must be sent to the director, Dr A Aggazzotti, Corso Raffaello 50, Turin, Italy, not later than July 1, with specifications as to the subject of research and the credentials from the government or institution

THE old mounting of the 18½ inch equatorial of the Dearborn Observatory, which has done service for nearly half a century, has just been replaced by an entirely new mounting from the firm of Warner & Swasey Observations with the new instrument were begun on June 1.

Nature states that the British Museum has acquired, at an almost nominal price, the valuable collection of specimens illustrating the religion of Polynesia, which was long in the possession of the London Mission Society Many of the specimens are unique, and it would now be quite impossible to form such a collection. Among the most remarkable objects are the great tapering idol of the national god of Raratonga, kept swathed in

blue and white matting, Tangaroa, the supreme god of Polynesia, a wooden figure with small human-like objects sprouting from his eyes, mouth and other parts of his body, typifying his creative power, and a head-dress of black feathers, which completes a mourning costume already owned by the museum

UNIVERSITY AND EDUCATIONAL NEWS

Swarthmore College has succeeded in its undertaking of raising a half million dollar endowment fund. In addition the heirs of the late Phoebe Anna Thorne, of New York, have given the sum of $200,000 to the college, making a total of $700,000 additional endowment. These increased resources will not be used to enlarge the college, but to strengthen it, to improve its present equipment, and to aid it in carrying on its work as a small college.

The gift of $100,000 in lands by James B and Benjamin N. Duke, of $50,000 for a new building by James B. Duke, and of $10,000 by B. N Duke for campus improvements, was announced at the commencement exercises of Trinity College, Durham, N C.

A gift of $20,000 to aid general research in the study of diseases, at the Yale Medical School, has been announced from Francis E. Loomis, of the class of 1864. Further gifts of $10,000, toward the endowment of the university clinic, and to the Peruvian exploration fund, for the Yale expedition under Assistant Professor Hiram Bingham, have also been announced For the exploration fund a total of about $12,000 has been pledged.

Mr. James R. Steers, '53, has made a further contribution to the Wolcott Gibbs library of chemistry at the College of the City of New York. He has endowed it with $5,000 in five per cent. bonds, the income to be used for upkeep.

McGill University has received from Lady Graham, honorary treasurer of the Dr. A. A. Browne memorial fund, the sum of $10,000, which is to be devoted to the establishment of a fellowship for the advancement of medical science.

We learn from *Nature* that the Mathematical Society and the Society of Applied Physics of Göttingen have given 100,000 Marks to a fund for the creation of an institute of mathematics in connection with the University of Gottingen. Two donations of 50,000 Marks from manufacturing houses have also been received

It is announced that a considerable addition to the laboratory of plant physiology of the Johns Hopkins University will be erected during the present summer This will include both laboratory and greenhouse space, adapted to advanced work and research

An Imperial University Congress will be held at the University of London in the summer of 1912

A new plan of studies at the Harvard Dental School will go into effect October next During the first half year the students will divide their time between chemistry and general anatomy, including dissection of the cat, embryology, organology and histology. During the second half year they will have human dissection including special work in the anatomy of the head, and they will also have at the same time physiology The courses have been entirely recast, but the concentration system of studies has been preserved The new plan has been adopted in the hope of gain from the logical sequence of the subjects.

Only the men of the college of letters and science, the school of medicine and the commerce courses will be expected to wear caps and gowns at the commencement exercises of the University of Wisconsin. Owing to the sentiment among the agricultural, law and engineering students they will not be asked to wear the cap and gown.

At the University of Michigan assistant professor R H. Curtiss, of the department of astronomy, has been made junior professor and assistant director of the observatory to take the place of Professor W. J. Hussey, during the latter's absence at La Plata University. Assistant professor S. J. Zowski, of the engineering department, has been made junior professor of mechanical engineering and Junior Professor Alfred Holmes White, of the same department, full professor of

chemical engineering Dr C H Kauffman, instructor, has been made assistant professor of botany Aubrey Tealdi, instructor, has been made assistant professor of landscape gardening, and Dr G L Jackson, instructor, has been made assistant professor of education Dr A G Ruthven, curator of the museum, has been made assistant professor of zoology

DR. J. G FITZGERALD has been appointed associate professor of bacteriology in the University of California

WILLIAM H WELKER, Ph D, has been appointed assistant professor of biological chemistry in Columbia University

M TISSOT, an assistant in the Paris Museum of Natural History, has been appointed professor of physiology in the museum

DR. WENZELL LASKA, of the Technical School at Lemberg, has been appointed professor of mathematics in the Bohemian University of Prague.

DR. ERHARD SCHMIDT, of Erlangen, has been called to the chair of mathematics at Breslau.

DISCUSSION AND CORRESPONDENCE

THE APPOINTMENT, PROMOTION AND REMOVAL OF OFFICERS OF INSTRUCTION

IN a recent paper under the above title[1] Mr Sidney Gunn makes the following references to Brown University

> Another illustration of the way the public takes removals can be found in the case of Brown University Repeated complaints have been raised of men having been cajoled, crowded or thrust out of the Brown faculty with varying degrees of suddenness and consideration In some cases the men so treated have served the university for many years without being found incompetent or even unworthy of regular promotion—something which in most institutions is regarded as establishing a claim that prevents removal on the ground of natural unfitness.

The paragraph quoted was to be sure part of the material of an argument against the contention of President Van Hise that public sentiment would always visit speedy condemnation upon a college president or corporation if the power of removal were unfairly or unjustly used. I am not inclined to disagree with this main thesis of Mr Gunn's paper, nor do I care to enter upon a discussion of the causes or conditions of removal of members of the faculty of Brown University in recent years Such discussion could serve no good purpose, and would only lead to futile controversy I do, however, deeply regret that a reference to Brown University should appear in SCIENCE from which every reader must inevitably draw the inference that the situation at Brown is typically bad with respect to the academic freedom and the tenure of office of its teachers, that the members of the Brown faculty do not enjoy a reasonable security of tenure but are liable, even after long and apparently satisfactory service, to be removed arbitrarily by the president or governing board

That its administrative body has never made an error of judgment is more than can be said, probably, of any long-established institution, but all friends of collegiate education Mr Gunn included, should be glad to know that the indictment contained in the statements and implications of Mr Gunn's paragraph referring to Brown is not justified by the policy of the university.

The permanency of tenure of office for professors is secured by the ancient charter of the university A professor can be removed only "for misdemeanor, incapacity or unfaithfulness" The president and governing boards at the present time also recognize the fact that security of tenure, in the long run, is to the university a financial asset as well as a necessary condition of continuous and contented scholarly work and the natural and appropriate reward of loyalty and of long and faithful service. It is the well understood policy of the university to construe the principle of tenure, in accordance with the spirit of the charter, as applying to those assistant and associate professors who have served many years satisfactorily.

Instructorships are considered to be tempo-

[1] SCIENCE, May 12, 1911, p 729.

rary appointments even after the salary is increased, and the promotion from an instructorship to an assistant professorship, while it carries with it encouragement and expectation of later permanence, does not immediately commit the university to a guarantee of permanent tenure This is reasonable, for, if the instructor for any reason does not fit the particular position, after a trial of a few years, no one interested in the welfare either of the university or of the instructor himself would desire that he be promoted to a professorial position Similarly if, after a few years, the assistant professor fails to fulfil the expectations which accompanied his promotion or appointment or if he apparently has reached the limit of his growth in the environment of the particular institution, no one can fairly object to his being advised, or urged if necessary, to seek elsewhere to establish his permanent professional position, provided, of course, that he is given ample time and friendly assistance to make the change

At Brown, those teachers, whether professors, associate professors or assistant professors who, as distinguished from these younger men, have served the university many years and have been encouraged to believe or allowed to suppose that their services have been satisfactory until the time is past for a reasonably fair chance of readjustment in other positions, are insured by the university's policy of tenure against being "cajoled, crowded or thrust out of the Brown faculty." Contrary to the inference which would naturally be drawn from Mr Gunn's paragraph, such service at Brown University "is regarded as establishing a claim that prevents removal on the ground of natural unfitness." The administration recognizes its responsibility in case it fails to diagnose natural unfitness in the course of the years of probational service.

In view of this recognized policy there is in the university a feeling of security of tenure and there is also an academic freedom of opinion, utterance and action which is ideal and is highly valued and appreciated by the faculty

A. D Mead
Brown University

CORRESPONDENCE WITH THE INTERNATIONAL COMMISSION ON ZOOLOGICAL NOMENCLATURE

The secretary of the International Commission on Zoological Nomenclature feels constrained to invite the attention of the members of the zoological profession to an important point in connection with the subject of correspondence

The commission is composed of fifteen members, elected by the International Congress of Zoology The duties involve a considerable amount of tedious labor All of the members give their time willingly to this work from a pure sense of duty to science and to their profession They do not ask nor do they receive one cent of remuneration for the many hours of time and work they sacrifice in order to endeavor to carry out the duties imposed upon them

At the urgent request of colleagues, additional labors have been undertaken that were not contemplated when the commission was originally formed in 1895

With the increase of duties, the correspondence has naturally grown to not inconsiderable proportions, and this additional correspondence brings with it increased labor and increased sacrifice of time

It is a pleasure to acknowledge the fact that many of the members of the profession seek to aid the commission by valuable suggestions and it seems needless to state that this friendly cooperation is heartily welcomed and appreciated

Some zoologists, however, appear to overlook the history, duties and purposes of the commission, and appear to assume that one of its objects and duties is to receive and read communications couched in language which is hardly within the bounds of diplomatic usage.

As the executive officer of the commission, and assuming full personal responsibility for this action, taken without consulting the other members, the secretary desires to give public notice that he insists that the same

courtesies be extended to the commission which it is customary to extend to other judicial bodies and other international committees. Suggestions, advice and objective arguments are welcomed, but polemics of all kinds will be consigned, unconsidered and unanswered, to the waste paper basket.

This public notice is given only after receipt of a number of letters couched in terms which it is exceedingly difficult to construe as within the bounds of professional courtesy or diplomatic usage.

CH. WARDELL STILES,
Secretary

THE ZOOLOGICAL RECORD

The Zoological Record, published annually by the Zoological Society of London, is now also the zoological volume of the International Catalogue of Scientific Literature, and is prepared with the active cooperation of the United States government, through the Smithsonian Institution. In spite of this, when the volume for 1909 came to hand recently, I was called upon to pay $2.50 duty, a larger sum than ever before. I thereupon applied to the Smithsonian Institution, and was informed that the *Record* appeared to be entitled to free entry, according to item 517 on page 71 of the Aldrich-Payne Tariff Bill of 1909. Armed with this information, I took up the matter with the U. S. Treasury, and after a lengthy correspondence with the authorities in Washington, New York and St. Louis, have received a check for the amount paid. I publish these facts for the information of other subscribers. It should be added, that not only is the *Record* entitled to free entry, but all "books and publications issued for their subscribers or exchanges by scientific and literary associations or academies."

T. D. A. COCKERELL

PRIMITIVE COPPER HARDENING

TO THE EDITOR OF SCIENCE: In his notably sane address on "The Lost Arts of Chemistry,"[1] Dr. W. D. Richardson refers to the question, much mooted among archeologists, concerning the hardening of copper in primitive art. While his general conclusion seems just, it is nevertheless liable to be questioned by collectors of primitive artifacts in this country and perhaps elsewhere. Some personal investigation of primitive copper artifacts indicates that for two reasons these are sometimes harder than is ordinarily attained by modern artisans. (1) While ordinary copper artifacts exhumed from mounds and other burial places are commonly coated with the green oxide, the edges of knives and sometimes other portions are patinated, and usually the patina (which may extend on both sides of the blade quite to its edge) is decidedly harder, albeit more brittle, than the unchanged copper. Not infrequently this patina is mistaken for the normal condition of the metal, and the collector regards his artifact as an evidence of artificial hardening beyond the reach of modern artisans. (2) Judging both from the condition of the prehistoric artifacts and from the methods pursued by primitive artisans, the copper implements of the American aborigines were commonly hardened by hammering, albeit rather adventitiously than intentionally. Now, in the process of working, the tools employed (corresponding to hammer and anvil) were not of steel or other resilient metal, but of stone, and experiment indicates that under the blows of an inelastic stone hammer on a thin blade resting on an inelastic stone anvil, the successive impacts are not so well distributed throughout the mass of the metal as are those produced by resilient steel tools, so that the blade undergoes a sort of skin-hardening, naturally culminating in the cutting edge. Of course this effect might easily be imitated by a modern artisan using primitive tools, yet it is a factor to be reckoned with in considering the widespread belief in the superior hardness of primitive copper artifacts. Speaking broadly, the notion of lost arts, which Dr. Richardson effectively combats, is a mischievous one. Of course throughout the long, devious and vacillating course of human progress, arts have disappeared—usually because replaced by superior arts. The indus-

[1] SCIENCE, Vol. XXXIII., 1911, p. 513 et seq.

trial arts especially rank among the most permanent, not to say eternal, of all the manifestations of humanity. It is hardly too much to say that only by the extinction of entire peoples are useful arts ever lost (except as superseded by more useful devices), and until well within the period of writing any arts possibly lost by extinction of peoples left little trace.

W J McGee

SCIENTIFIC BOOKS

Light and the Behavior of Organisms. By S. O. Mast. New York, John Wiley and Sons. 1911.

While the present volume deals primarily with the question of the orientation of organisms the author tells us that it "may be considered a treatise on the behavior of organisms in their reactions to light." The first three chapters constituting Part I. are devoted to the historical setting of the subject and the statement of general problems and view-points. Part II. is concerned with the way in which organisms turn towards or from a source of stimulation. In addition to giving a very good résumé of the observations of others upon orientation this part contains a considerable amount of new material from the author's own researches. These include investigations of orientation in Indian corn, *Nasturtium, Amœba, Euglena* and a few other flagellates, the swarm spores of *Œdogonium, Hydra, Eudendrium* and some worms and insect larvæ. In general this work gives evidence of having been done with care and accuracy and adds materially to our knowledge of the general *modus operandi* of orientation. It is evident now to every one who has followed the work in this subject during the past few years that orientation is accomplished by a great variety of methods in different organisms. There is no such thing as a general scheme of orientation.

Loeb's theory of orientation is the author's favorite object of attack and he recurs to this doctrine and certain other views of Loeb with the persistence of Cato in urging the destruction of Carthage. It is not difficult to adduce cases that do not fall under Loeb's explanation of the way in which animals become oriented, but some of Mast's own investigations seem to afford about as good support as has been furnished for the theory which he so persistently attacks. No clearer case of orientation through the local response of the part directly stimulated could well be imagined than the one afforded by *Amœba,* and the author admits that the "method of orientation is in harmony with much in Verworn's theory and also with the essentials in Loeb's." But he adds that "it does not, however, support the idea connected with these theories, that a constant intensity produces a constant directive stimulation." I am not sure that I understand the pertinency of the criticism, for there is nothing in the theories of either of these writers which implies that the actual stimulating effect of any directive agency is subject to no variation. Both of these writers have adduced several cases which show that such variation occurs, and it is out of the question to suppose that either of them has overlooked the obvious importance of internal changes in determining the way in which an animal responds.

The author's experiments on the larvæ of *Arenicola* are of especial interest in regard to the problem of orientation. There is no reference either in the text or in the bibliography to the previous work of Lillie on the method of orientation in this form, although there is a quotation from a paper by Lillie dealing with certain features of its structure and development. The observations of Lillie are in general confirmed, but Mast has performed several additional experiments which bring out more clearly the fact that orientation is "due to difference of intensity on opposite sides" of the organism. The orienting response is shown to be due to light falling upon the eyes, the other parts of the body being apparently insensitive to this stimulus. When the larva is suddenly illuminated on one side there are no random or trial movements, but the head is bent directly toward the source of light. All the evidence points to the conclusion that orientation is the result of comparatively

simple reflex responses The question remains open whether the stimulus is produced by the direct action of light on the sensitive surface of the animal or by changes in intensity of the stimulus caused by the lateral movements of the body The question in this as in many other cases is difficult to decide Analogy with the method of orientation in *Euglena* leads the author to incline toward the latter alternative, but the experimental data obtained did not enable him to solve the problem. In either case orientation in this form is apparently as automatically regulated an activity as one might expect according to the well-known theory of Loeb

The problem of whether the rays of light *per se* or variations of light intensity *per se* afford the stimuli which cause orientation is discussed in connection with accounts of experiments on the blow fly, earth-worms and other forms There is much to be said for the efficiency of both these factors in special cases There are instances in which the shock of transition from one light intensity to another causes a marked reaction Light in other cases has a constant stimulating effect apart from any shock of transition In an organism going towards or away from the light deviations from the direct course produce a change of intensity of light falling on its two sides, that the animal turns directly and automatically into line does not of itself enable one to decide whether it turns because it is more strongly stimulated on the one side than on the other, or whether it turns on account of a change of light intensity There have been few attacks upon this particular problem and the author does well to bring it into more prominence than it has usually been accorded

Part III, entitled General Considerations on Reactions to Light, deals chiefly with the various methods of forming groups in regions of certain optimum illumination, reactions which involve no directive effect of light, and the factors which induce changes in the phototactic response. There is no discussion of any theoretical attempt to explain the reversal of phototaxis and the author advances no views of his own.

Part IV deals with reactions to light of different wave-lengths Much work in this field has given inconclusive results on account of failures to obtain pure monochromatic light and on account of not taking into consideration differences in energy of different wave-lengths While in general the rays toward the violet end of the spectrum are more potent in producing the heliotropic response in both plants and animals, the rule is not without exceptions in both kingdoms As the writer states, this is probably due to the fact that some chemical processes are accelerated by light of certain wave-length, while other chemical processes are accelerated most by light of a different wave-length Sometimes monochromatic light is more potent than white light, a fact which suggests that certain rays tend to inhibit or reverse chemical reactions which are caused by rays of a different wave-length Mast's treatment of the effect of light of different wave-lengths can not fail to be very helpful to all workers in this rather difficult subject

The final chapter on Theoretical Considerations contains, besides a general summary of results, a renewed attack upon Loeb, a short consideration of the much-refuted vitalism of Driesch, and an exposition of the general position of Jennings to which the author is a very close adherent. After stating that according to Jennings's views the reactions of an organism are fundamentally purposeful and that they depend upon previous activity as well as present external conditions, the author expounds the position of Jennings as follows "Reactions are defined as changes in the activity of organisms Such changes may occur under constant external conditions They are therefore due primarily to internal changes External factors cause reactions not directly, but indirectly, by altering internal processes (physiological states). Variability in reaction to given external conditions is due to changes in physiological states If an organism responds to light of a given intensity in a given way now, and to the same intensity in another way later, it is because the physiological state of the organism has changed" Fol-

lowing this with a statement of the principle of association, Mast continues

> Every step in the development of the theory is supported by numerous experimental facts and all seems to fit with what is known concerning the reactions of organisms Reactions, according to the theory, are as stated above, primarily due to physiological states External agents ordinarily produce reactions through the effect they have on these states By the application of this idea all the different phenomena connected with reactions to light as summarized at the beginning of this chapter can be accounted for

All this sounds rather naive as compared with the critical exposition of the preceding part of the volume It would indeed be comforting to be able to repose with such a spirit of confidence and contentment in a general philosophy of behavior, but it is perhaps pertinent to enquire if the author has not been deceived with the delusive appearance of explanation where no real explanation has been given It is an obvious truism that external factors cause reactions by altering internal processes, else they would not be reactions at all. It is equally obvious that if changes of behavior occur where external conditions do not vary they must be due to the fact that internal conditions do vary; or, in other words, if the cause of a change is not outside of the organism it must perforce be inside of the organism Phenomena may thus be "accounted for" on the basis of varying internal states, but as it is admitted that in most cases we are entirely ignorant of what these states are we are about as much enlightened as we are by the celebrated explanation of the sleep-producing effect of opium by attributing it to a dormitive principle.

There is a useful bibliography in which the effort is made to include all the important works on reactions to light in both animals and plants, but several noteworthy contributions are not included Notwithstanding minor defects, the work of Mast will prove of great value to students of the effect of light on the behavior of organisms, and the author is to be congratulated on having made so substantial a contribution to the subject.

S. J. Holmes

A Laboratory Manual of Physical Geography By R S. Tarr and O D von Engeln. New York, The Macmillan Company 1910.

Tarr and von Engeln's "Laboratory Manual of Physical Geography" is the most practical and best organized manual that has yet appeared Prepared as an exercise and notebook, with detachable leaves, and containing within its covers a large part of the necessary equipment for work, except for topographic maps, minerals and certain simple pieces of physical apparatus, it is a hand-book and guide available for both the expert and inexpert teacher Although primarily devoted to the study of physical geography, much emphasis is made of life relations and therefore the book not only meets a present condition, but makes possible a development of the phase of geography which is beginning to be emphasized by the better secondary school teachers

Of the seventy-three exercises in the book, nine are devoted to the earth as a globe, seven to excursions, eight to minerals and rocks, five to map study, twenty-six to the physiography of the lands, two to the ocean, fourteen to the atmosphere and one each to life zones and magnetism

Thus the special emphasis is good, though it is questionable whether mineral and rock study deserves to remain in physical geography and whether the ocean is not given too little emphasis The larger life relations to the ocean, apart from the phenomena associated with ocean currents and tides, are so important and fascinating that it seems unreasonable to omit them, while space is given to minerals and to the physical phenomena of condensation Laboratory work should be devoted to topics that are not capable of being learned more easily and more effectively through demonstration, and certainly condensation can not be included in this class.

The order of treatment under the land forms is original in that types of plains are studied in relation to drainage and not following drainage, and thus a better unity is preserved. Mountains are grouped according to

origin and presented in a similar all-round way The later exercises under this head are listed according to their distribution in the United States and not primarily according to the class to which they belong

Taken as a whole, however, the volume has few elements of weakness and many of strength It has been tested in practise with beginning pupils and hence is not too advanced or specialized It is a most valuable contribution to educational geography and ought to help strengthen and humanize physical geography teaching in our high schools, and it should be remembered that for many years such work has been unhuman, if not at times almost inhuman

RICHARD E DODGE

TEACHERS COLLEGE,
COLUMBIA UNIVERSITY

The Principles of Electro-deposition A laboratory guide to electro-plating By SAMUEL FIELD, A R C Sc (Lond), F C S New York, Longmans, Green & Co. 1911, 12mo Pp xv + 383

This is one of those manuals designed for the purpose of interesting further the purely technical worker, so that he may be led to learn something at least of the principles upon which the operations he observes daily are based

After considering the apparatus for the production, regulation, and measurement of the electric current, plating with copper, nickel, iron, tin, zinc, silver, gold and brass are taken up in detail, from the theoretical as well as the practical viewpoint, the methods of preparing the object for plating, as well as the finishing, after that process is complete, also being considered. This is followed by several chapters on the methods for the qualitative and quantitative analysis of the substances employed in the various processes

Whether the worker will actually gain the knowledge which the author hopes he may is a question, for much depends upon the elementary knowledge which can be assumed to be in the possession of the reader. One thing is quite certain, however,—the readers, or at least some of them, will find their interest greatly aroused by a perusal of this book, even though it may not be thoroughly understood, with the result that they may be led to seek some school where a thorough training in the subject may be acquired Books of this type are of the greatest value, for it is to them that we must look for the first step in that great advance in industrial work – the perfect combination of theory and practise

J L R M

SCIENTIFIC JOURNALS AND ARTICLES

ANNOUNCEMENT is made of the establishment of *The Journal of the Washington Academy of Sciences* It is to be a semi-monthly publication and will be sent to subscribers on the first and fifteenth of each month, or during the summer may appear on the fifteenth only, as double numbers The first number will be issued about July 15, but after 1911 the volumes will correspond to the calendar year The present *Proceedings of the Washington Academy of Sciences* will be discontinued after the completion of the current volume The *Journal* will be a medium for the publication of original papers and a record of scientific work in Washington It will accept for publication (1) brief papers written or communicated by resident or non-resident members of the academy, (2) abstracts of current scientific literature published in or emanating from Washington; (3) proceedings and programs of the affiliated societies, and (4) notes of events connected with the scientific life of Washington The editors are George K Burgess, Bureau of Standards, Barton W Evermann, Bureau of Fisheries, and Frederick Leslie Ransome, Geological Survey Illustrations will be used only when necessary, and will be confined to text figures or diagrams of simple character The editors, at their discretion may call upon an author to defray the cost of his illustrations, although no charge will be made for printing from a suitable cut supplied with the copy.

THE contents of the *Astrophysical Journal* for June are as follows:

"On Doppler's Principle in Connection with the Study of the Radial Velocities on the Sun," A. Cotton.

"On the Magnetic Separation of the Spectral Lines of Calcium and Strontium," B. E. Moore.

"On the Radiation of the Companion of Algol," Joel Stebbins.

"On Regularities in the Spectrum of Neon," Herbert Edmeston Watson.

"Application of the Interference Method to the Study of Nebulæ," Ch. Fabry and H. Buisson.

"Observations of Nova Lacertæ at the Yerkes Observatory," Edwin B. Frost.

"Photographic Determinations of Stellar Parallax made with the Yerkes Refractor." VI, Frank Schlesinger.

The June issue of the *Journal of Comparative Neurology* contains the following articles:

"The Evolution of the Sympathetic Nervous System in Vertebrates," Albert Kuntz.

"The Olfactory Nerve and the Nervous Terminalis of Ameiurus," Charles Brookover and Theron S. Jackson.

"The Nervus Terminalis in Urodele Amphibia," Paul S. McKibben.

"Localization of the Motor Area in the Sheep's Brain by the Histological Method," Jessie L. King.

PRE-COLUMBIAN REFERENCES TO MAIZE IN PERSIAN LITERATURE

That maize is of American origin is no longer a disputed question, but the discussion of the possibility of its having been known in Europe and in the east before the discovery of America by Columbus is by no means closed.

There was much written on this subject in the first quarter of the nineteenth century, and one of the historical references to which much importance was attached is an alleged mention of *rous* by Mirkhond, a Persian historian of the fifteenth century (1433–1498). The authority for the existence of such mention by Mirkhond is Herbelot, an orientalist of note, who uses the word *rous* as synonymous with *blé de Turquie*, which was a name for maize in common use at the time.[1]

Under the word Rous, in the "Bibliothèque orientale," Herbelot says (italics ours). "Rous. Name of the eighth son of Japhet, son of Noah, from whom Russia, which we now call Muscovy, has taken its name. Mirkhond wrote in the genealogy which he has given us of the Mogols, ancestors of Jenghiz Khan, that Rous was of a very different disposition from his brother Khozar . . . so that Khozar was obliged, in order to live in peace with his brother to yield to him all the islands of this great river (Volga) which empties into the Sea of Khozar which we call Caspian. Rous sowed in all these islands the wheat which we call *de Turquie* and which the Turks still call, to-day, in their language, by the name of *rous* and boulgar."[2]

Bonafous, in his monumental work on maize quotes the above and says (italics ours). "The celebrated orientalist, Herbelot, refers to a passage from Mirkhond, a Persian historian of the fifteenth century of which the translation, *if it is exact, would leave no doubt that maize was known in the Old World before the discovery of the New*."[3] Bonafous proceeds to say, however, that after an examination of the text of Mirkhond, at the place

[1] Harshberger, "Maize: A Botanical and Economic Study," University of Pennsylvania, Contributions from the Botanical Laboratory, Vol. 1, p. 89, Browne, "Maize or Indian Corn," American Institute, Annual Report, Vol. 5, 1847, p. 412.

[2] "Rous. Nom du huitième fils de Japhet, fils de Noé, duquel la Russie, que nous appellons aujourd'hui Moscovie, a pris son nom. Mirkhond écrit, dans la généalogie qu'il nous a donnée des Mogols, ancêtres de Ginghizkhan, que Rous étoit d'une humeur bien opposée à celle de son frère Khozar, . . . en sorte que Khozar fut obligé, pour vivre en paix avec son frère, de lui céder toutes les isles de ce grand fleuve qui se décharge dans la mer de Khozar, que nous appellons Caspienne. Rous fit semer dans toutes ces isles *le bled* que nous appellons *de Turquie*, et que les Turcs appellent encore aujourd'huy en leur langue du nom de *rous* & boulgar." (Herbelot, "Bibliothèque orientale," 1777–78, Vol. 3, p. 137.)

[3] "Le célèbre orientaliste d'Herbelot rapporte un passage de Mirkhond, historien persan du quinzième siècle, dont la version, *si elle est exacte, ne laisserait pas douter que le maïs n'était connu dans l'Ancien-monde avant la découverte du Nouveau*." (Bonafous, "Histoire naturelle du Maïs," 1836, p. 22.)

indicated by Herbelot, he finds nothing to justify the latter's statement in regard to *rous*, and adds, as he dismisses the subject, "Either this author must have drawn from some other source than that which he indicates, or a strange confusion must have prevailed among the notes which he had collected"[4]

This judgment of Bonafous' seems for the time to have closed the question, but the investigation of the subject of the origin of maize in connection with some bibliographical work being done in the Bureau of Plant Industry, of the United States Department of Agriculture, has revealed the fact that several scholars of note agree that Herbelot and others often ascribed to Mirkhond statements which were really taken from the writings of Khondemir[5] (1475–1534)[6]

Khondemir wrote at almost the same time as Mirkhond, although he was his grandson,[7] and his best known work, the Khelassé-al-âkhbar, is very nearly identical in subject matter with Mirkhond's History of the world, the Rauzet-al-safa Reinaud says "The Khelassé-al-âkhbar which, however, is for the most part only an abridgment of the Rauzet-al-safa, composed by Mirkhond, has furnished Herbelot with a large part of his historic articles"[8]

[4] "Ou cet auteur aura puisé à une autre source que celle qu'il indique, ou une étrange confusion se sera mise dans les notes qu'il avait rassemblées" (*loc. cit*)

[5] Variously spelled, Khondemir, Khwand amir, Chuandamir

[6] Silvestre de Sacy, "Mémoires sur diverses antiquités de la Perse," p xiii, Langlès, in "Notices et extraits des manuscrits de la Bibliothèque nationale," Vol 5, 1799, p 193, Audiffret, in Michaud, "Biographie universelle," Vol 29, 1821, p 133

[7] Khondemir is often spoken of as the son of Mirkhond, but he himself says that Mirkhond was his maternal grandfather (Rieu, "Catalogue of the Persian Mss in the British Museum," 1879, Vol. 1, p. 96.)

[8] "Le Khelassé-al-âkhbar . . . qui, du reste, n'est le plus souvent qu'un abrégé du Rauzet-al-safa, composé par Mirkhond, a fourni à d'Herbelot une grande partie de ses articles historiques." (Reinaud, in Michaud, "Biographie universelle," Vol 22, 1818, p 378)

The similarity of subject matter in the two works is shown by a comparison of the summaries of the two parts in which we are especially interested—part 9, of the Khelassé-al-âkhbar, and part 5, of the Rauzet-al-safa Of the former Reinaud says, "The author goes back to Japhet He undertakes to relate everything worthy of note that has happened in the northern countries of Asia, and then gives many details of the wars of Jenghiz Khan and of his descendants"[9] Of part 5, of Mirkhond's Rauzet-al-safa, Jourdain says "Introduction to the history of Jenghiz Khan, in which Mirkhond traces that of some Tartar and Mogol princes from Japhet, son of Noah, to this victorious Mogol"[10]

Having thus seen, first, that the two authors, Mirkhond and Khondemir, were often confused, and second, as a reason for the confusion, that the subject matter of the Khelassé-al-âkhbar of Khondemir and the Rauzet-al-safa of Mirkhond is, for the most part, the same, it seems reasonable to advance the conjecture that Herbelot drew his information from Khondemir rather than from Mirkhond, and that this probable error in crediting the quotation accounts for the failure of Bonafous to verify the reference

The statement concerning maize ascribed to Mirkhond loses none of its value in the investigation of the early history of maize, if taken from the writings of Khondemir, so that an examination of his writings, especially part 9, of the Khelassé-al-âkhbar, becomes important A copy of this work is in the

[9] "L'auteur remonte jusqu'à Japhet Il s'attache à relever tout ce qui s'est passé de remarquable dans les contrées septentrionales de l'Asie, et fournit ensuite beaucoup de détails sur les guerres de Djenguyz khan et de ses descendants" (Reinaud, in Michaud, "Biographie universelle," Vol 22, 1818, p 379.)

[10] "Introduction à l'histoire de Djenghiz khan, dans laquelle Mirkhond trace celle de quelques princes Tartares et Mogols, depuis Japhet, fils de Noé, jusqu'à ce conquérant Mogol" (Jourdain, in "Notices et extraits des manuscrits de la Bibliothèque nationale," Vol. 9, 1818, p. 135.)

Library of the British Museum,"[11] but we do not know of a copy in this country We shall be glad to be informed if there is a copy in an American library. MARY G LACY

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U S DEPARTMENT OF AGRICULTURE

TERRESTRIAL MAGNETISM

THE results of magnetic observations made by the Coast and Geodetic Survey between July 1, 1909, and June 30, 1910, have recently been printed at the Government Printing Office in Washington The report is edited by R L Faris, Inspector of Magnetic Work, assistant, Coast and Geodetic Survey The report includes the values of the three magnetic elements as measured during the fiscal year, at two hundred and thirty-two stations on land distributed through thirty-nine states and territories Several other land stations were occupied and partial results are given for these Of this number, seventy-five were "repeat" stations, nearly one third of the whole number "The resulting values of annual change show that, as compared with 1905, west declination is increasing more rapidly in New England and the Middle States and east declination is increasing more rapidly in the western part of the country. The position of the line of no change is apparently about the same as in 1905" The year 1905 is doubtless referred to because to that year the last and most complete declination charts yet printed for the entire country were uniformly reduced. The results of a considerable number of observations at sea are given in this report In connection with the land work, the continuous records of the magnetic observatories, five in number, were available, except for the time during which the instruments of the observatory at Baldwin, Kans, were being removed to Tucson, Ariz, the observatory at the former place being discontinued in October, 1909, and a new one established at the latter in November, 1909. F. A. MOLBY

CORNELL UNIVERSITY

[11] Rieu, "Catalogue of the Persian Mss. in the Library of the British Museum," 1879, Vol. 1, pp. 96-97

SPECIAL ARTICLES

REDISCOVERY OF SOME CONRAD FORMS

T A CONRAD in "Description of Cretaceous and Tertiary Fossils," published in part two of the Report on the United States and Mexican Boundary Survey, describes and figures the following cretaceous forms collected by Arthur Schott, ascribing them to the localities given

Mactra texana,	Prairie between Laredo and Rio Grande City
Cardium congestum,	Devils River
Rostellaria? collina,	Between Devils River and the Pecos.
Rostellaria? texana,	
Natica collina,	
Natica texana,	
Buccinopsis parryi,	

The first-named locality is in the Eocene and at the others only rocks of Fredericksburg and Washita are exposed These forms have not since been found in either locality named and I have not been able to find any record of their having been recognized, since the time of their description, anywhere else in this region, although, as will be shown later, one or two of them have been collected by other workers in this field

In working over the collections made in January, 1909, by Messrs W. F Cummins and W Kennedy along the Rio Grande below Eagle Pass, I found a number of fairly good specimens of each of the species named

Our localities and collections are as follows

Mouth of Cuevas Creek·
Rostellaria? (*Volutomorpha*) *texana* Con.
Cardium congestum Con

One and one half miles above Las Isletas:
Mactra texana Con.
Pholadomya sp.
Buccinopsis parryi Con.
Rostellaria? (*Volutomorpha*) *texana* Con.
Etc.

Wash 1 m above Las Isletas·
Sphenodiscus pleurisepta Con.
Ostrea cortex Con.
Mactra texana Con.

Pholadomya sp
Cardium congestum Con
Buccinopsis parryi Con
Rostellaria? (*Volutomorpha*) *texana* Con
Pugnellus sp Etc

Las Isletas
Sphenodiscus pleurisepta Con
Mactra texana Con
Cardium congestum Con
Turritella sp Etc

Arroyo Toro Colorado, 1 m below Las Isletas
Sphenodiscus pleurisepta Con
Nautilus dekayi?
Ostrea sp
Mactra texana Con
Crassatella sp
Cardium congestum
Breviarca sp
Buccinopsis parryi Con
Pugnellus sp
Natica collina Con
Natica texana Con
Rostellaria? (*Volutomorpha*) *texana* Con
Etc

This locality also furnishes a number of specimens of crabs

A selection of specimens representing several of the species under discussion, together with a number of others occurring in the same beds, were submitted to Dr T W Stanton, of the United States National Museum, and my identifications of the Conrad forms were confirmed by Dr L W Stephenson, who states that the *Rostellaria?* of Conrad is a Volutomorpha

Major Emory, in the first part of the Boundary Survey report, on page 68, gives a description of Las Isletas and the falls of the Rio Grande with a full-page illustration opposite This description would indicate that the falls of the Rio Grande and Las Isletas were the same The truth is that Las Isletas is located about the mouth of Castaño Creek, while the falls are some four miles lower down the river just below the mouth of Caballero Creek

It will thus be seen that our collections were made from localities directly on the line of travel of the Boundary Survey party and it seems highly probable that the original specimens described by Mr Conrad were in reality obtained from these same beds

The horizon is the uppermost portion of our Escondido beds The fossils are among the latest Cretaceous forms of which we have any present knowledge in this region

The Cretaceous-Eocene contact is well shown three miles below Toro Colorado, just above the falls of the Rio Grande and on Caballero Creek

The only other records I can find of any of these forms are as follows

Professor G D Harris, in "The Tertiary Geology of Southern Arkansas," gives a list of fossils collected by Dr C A White in 1887 at his camp eighteen miles southeast of Eagle Pass, Texas, which were supposed to be basal Tertiary Among these there is a cardium which Mr Harris figures both in this paper and later with his Midway fauna "Bulletin of American Paleontology, No 4," without giving it a specific name

This camp was probably at the Eagle Pass-Laredo road crossing near the junction of Cuevas and Peña creeks and on or near the Cretaceous-Tertiary contact The cardium is unquestionably the *Cardium congestum* of Conrad, while the other forms named by Professor Harris are from the overlying Midway.

Mr T W Vaughan in his Report on the Rio Grande Coal Fields of Texas gives a list of fossils collected 18½ miles southeast of Eagle Pass This must also have been in the same vicinity His list contains a form identified as "*Mactra* cf *mooreana*" which, in view of our later discovery, may be more properly called *Mactra texana*, and *Cardium* cf *eufalense* may be *Cardium congestum*.

E. T DUMBLE

BACTERIOLOGICAL METHODS FOR THE ESTIMATION OF SOIL ACIDITY

THE general prevalence of acidity in the older soils of the United States has been the cause of increasing comment, within the past few years. It is well known that the tendency of cultivated soils to become acid is intensified by the use of commercial fertilizers, and, gen-

erally, by the more intensive methods in vogue in portions of the eastern states. Since profitable cropping becomes impossible in soils that are strongly acid, the liming of soils is now receiving a good deal of attention. The subject of lime and liming is freely discussed in the agricultural press, and the experiment stations are asked to supply farmers with detailed information as to the amounts and kinds of lime needed for different soil types, and for different systems of cropping. In view of the constantly increasing interest in lime and its application, it is desirable that reliable methods be provided for estimating the lime requirements of soils. The search for chemical methods that would supply the desired information was begun many years ago, and a considerable number of methods have been proposed as suitable for this work, unfortunately, however, agricultural chemists find themselves unable to decide on any chemical method that would give reliable results. Some years ago a method was proposed by Tacke that proved of certain value for the moor soils of Germany. More recently Süchting has attempted to improve the method by correcting certain defects in it, but even in its improved state the method leaves much to be desired, it is cumbersome and far from reliable. Similarly, methods have been proposed in the United States by Pettit and Hopkins and, also, by Veitch. These methods have been tested under different conditions, and have failed to give concordant results.

In view of the lack of a satisfactory method for the quantitative estimation of soil acidity, and in view of the evident need for a method of this character, it is eminently proper to make a careful study of new methods that seem at all promising. Among the new methods that could be suggested, for this work, the writer would include methods based on certain bacteriological reactions. It is well known that the development of bacteria in any culture medium is directly affected by the reaction of the latter. When the acidity of the medium is increased beyond a certain point, bacteriological development is retarded, or entirely stopped. For this reason, it appears evident that if to any neutral medium there be added increasing quantities of acid soil, a point will be finally reached when the acid in the soil added would preclude further development of the organisms. Following out this line of thought, the writer prepared a series of media of varying reaction. Several portions of bouillon were prepared and adjusted to the following reactions: (*a*) Neutral, (*b*) one half per cent. acid, (*c*) one per cent. acid, (*d*) one and a half per cent. acid, (*e*) two per cent. acid, (*f*) three per cent. acid.

When portions of these media were inoculated with pure cultures of *B. mycoides* or *B. subtilis*, growth occurred in the bouillon containing up to two per cent. of acid; beyond that the growth was very slight. When similar portions of bouillon had added to them one half gram, one gram, three grams, five grams and ten grams of soil, respectively, growth occurred in the different tubes depending on the amount of acid present in the medium, or that supplied by the soil. If, previous to the addition of the soil, the latter was mixed with ten per cent. of its own weight of calcium carbonate, growth occurred in all of the tubes, even those that had contained bouillon with three per cent. of acid.

These preliminary experiments demonstrated, therefore, that the amount of acid present in cultivated soils may be determined quite accurately by comparing bouillon of varying reactions with equivalent quantities of neutral bouillon containing varying amounts of soil. The proposed method may be utilized in still another direction, in that varying quantities of soil be added to measured amounts of bouillon, and, after sterilization, the bouillon be inoculated with a standard culture of ammonifying bacteria. At the expiration of a certain length of time the ammonia formed could be distilled off, and determined in the usual way. Since the acid added by the varying quantities of soil would affect the development of the organisms to an unequal extent, the amounts of ammonia formed might be used as a fairly accurate measure of the retarding effect of the acid present in the soils. The quantitative rela-

tions may be established by comparing bouillon thus provided with varying amounts of soil with equivalent portions of bouillon, to which varying amounts of standard acid had been added.

Instead of employing ammonifying bacteria for estimating the acid present in soil samples, nitrogen-fixing species of the *Azotobacter* group could be used. It is well known that *Azotobacter* will grow by preference in neutral or slightly alkaline media, hence, mannite solutions could be made up and portions of it treated with varying amounts of soil as described above. After sterilization and cooling, the several portions could be inoculated from some pure culture of *Azotobacter*. At the end of a given length of time, the total nitrogen present could be determined and the amounts fixed used as a guide in measuring the retarding effect of the acid present in the soil sample. In the same way, nitrifying or other bacteria could be utilized for the quantitative estimation of soil acidity. It is expected that the data accumulated by us will be available for publication at an early date.

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AN INTERESTING OLD WEAVING TECHNIC

ON a recent expedition of the American Museum to the Pima-speaking tribes of southern Arizona there was found the remnant of an old technic in basket-work which has almost entirely disappeared from this people.

It is a crude wrapping of a pliable binding element over stiff slats which are arranged in parallels—a wrapped weaving and found with three variations.

It appears on a few old house doors, shelves, cradles and cages in the out-of-the-way villages where the people have still preserved the early mode of construction and it seems the simplest way of uniting stiff slat-like strips by means of a soft pliable binding element.

This binding element was formerly of thong or native string—both occasionally met with now—but more recently it is of white man's rope, strips of cloth or even wire. The slats are generally the smooth, light ribs of the giant cactus Saguara. These are placed in a parallel series, while in the simplest forms of wrapping the binding element passes forward over two slats on the outside, backward over one on the inside and then repeats the process, thus forming a simple wrapped weaving. When greater strength is needed an extra slat is placed perpendicularly across the parallel series and bound to them by each wrap of the binding element, which in more frequent varieties gives an extra turn about each slat. This last technic is known as lattice wrapped weaving.

The possible evolution of the last crude basket technic from the simple process of the tying of twigs and fibers in their latticed house construction is interesting, as well as a similar development of the wrapped weaving from the plain bindings on one type of their cradles.

Indeed the thought suggests itself, might it not be possible that this crude wrapped weaving, because of its great simplicity, was one of the earliest to develop, especially in regions as destitute of suitable basket material as the desert country of the Pima? May not this technic hold a place with the others which lay claim to be the earliest technics—plaiting, with its over and under passing strips, wicker, with its interlacing twigs, wattling, with its twining elements?

Lattice wrapping repeats itself among the wild tribes in a number of the Malaysian Islands in crude traps and baskets, and on the Lower Congo in more refined basket work. Could its distribution through the desert region of America during early times be more closely traced, no doubt, we would find it a frequent technic, for it appears as far south as Mexico in the wagon box of the old oxcart. A close surface of the same technic also exists to the north among the Pomo, the Nez Perce, the Makah and on some of the old Salish blankets.

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SOCIETIES AND ACADEMIES

THE HELMINTHOLOGICAL SOCIETY OF WASHINGTON

The fifth regular meeting of the society was held in the rooms of the zoological division of the Public Health and Marine Hospital Service on March 14, 1911, Dr Stiles acting as host and Dr Ransom as chairman The following foreign corresponding members were elected Raphael Blanchard, Max Braun, Otto Fuhrmann, I Ijima, L A Jagerskiold, S J Johnston, Robert T Leiper, Otto von Linstow, Arthur Looss, Max Luehe, Sir Patrick Manson, Francesco Monticelli, L G Neumann, George H F Nuttall, Corrado Parona, Edoardo Perroncito, Theodor Pintner, Alcide Railliet, Arthur E Shipley and Fritz Zschokke.

Dr. Garrison gave a summary of a report by Surgeon C S Butler, U S Navy, and himself upon the parasites found at autopsy upon dogs, cats and rats at the U S Medical School during the past year Twelve dogs, ten cats and ten rats (*Mus documanus*) were examined with the following results

Dogs—*Filaria* (species undetermined), two infections, *Ascaris canis*, five infections, *Trichuris depressiusculus*, one infection, *Ancylostoma caninum*, five infections, *Tænia pisiformis*, three infections, *Dipylidium caninum*, six infections

Cats—*Ascaris canis*, eight infections, *Tænia teniaeformis*, two infections, *Dipylidium caninum*, six infections

Rats—*Trypanosoma lewisi*, one infection, *Trichinella spiralis*, one infection, *Trichosoma hepaticum*, four infections, *Trichosoma crassicauda*, seven infections (two bladders not examined), *Heterakis spumosa*, eight infections, *Hymenolepis nana*, one infection (in white rat), *H diminuta*, five infections, *Cysticercus fasciolaris*, eight infections

In addition, the examination of about twenty cock roaches showed infections with *Amœba blattæ* and numerous ciliates and flagellates. No gregarines were found

Dr Stiles called attention to the desirability of using fresh material for parasite study in class work

The secretary read a short note by Mr. Crawley on *Trypanosoma americanum* This parasite has been found in dried smears of centrifuged bovine blood This is of interest, since the trypanosome has hitherto been found only in bouillon cultures of the blood. The morphology of the organism as found in the fresh blood is the same as that of specimens appearing in culture tubes.

Mr Hall presented a paper entitled "The Limitations of Fecal Examination as a Means of Determining Existing Parasitism of the Digestive Tract" Certain writers have claimed a relation between the number of parasites present in any host and the number of eggs in a given amount of fæces from that host. This does not appear to be a general truth with wide application Besides the element of chance in the detection of eggs, there are certain conditions which permit of parasitism of the digestive tract without eggs in the fæces to indicate it Some of these conditions are (1) Infections with nematodes, usually light, where only males are present, (2) recent infections, at times heavy, in which the infecting larvæ of any species have not yet reached the egg producing stage, (3) interruption of egg production, as by breaking of strobila in tapeworms, or cessation of egg production, as in the case of barren nematodes, (4) irregularity of passage of eggs from the host, due to purging, passage of mucus, diarrhœa, use of thymol or alcohol, etc Consecutive and careful examinations of the fæces of a given animal show days when eggs of various kinds are abundant and days when they are scarce or missing This would be particularly true of cestodes Negative examinations must be considered doubtful and must be checked at intervals if infection is suspected

Dr Stiles presented a paper entitled "A Comparison of New England and Southern Mills with Reference to Natural Advantages and the Presence of Parasitic Diseases"

The sixth regular meeting of the society was held in the rooms of the zoological division of the Public Health and Marine Hospital Service on April 11, 1911, Dr Stiles acting as host and Dr Garrison as chairman.

The following American corresponding members were elected F D. Barker, Cooper Curtice, C A Kofoid, E Linton, W S Nickerson, H S. Pratt, Allen J Smith, L. D Swingle, A E Verrill, H. B Ward, Creighton Wellman, D G Willets and R. T. Young

Dr Stiles presented a note on a case of poisoning by the Portuguese man-of war. The poisoning had been attributed to the fish which commonly accompanies this cœlenterate. This was an error, as the stings were due to the jellyfish itself. These stings were very painful and persisted for some time in spite of treatment. The subject of poisoning by jellyfish is one that has not received adequate study.

Dr. Stiles presented a second note on the findings in fecal examination of 82 southern school children aged six to twelve years. Infection with hookworm was found in 5 per cent, with *Ascaris* in 41 per cent, with *Trichuris* in 15 per cent and with *Hymenolepis nana* in 6 per cent.

Dr. Ransom presented a paper entitled "A New Cestode from an African Bustard" in which was described a new species and genus, belonging to the family Davaineidæ. The specimens on which the description is based were collected by Mr. Loring, of the Roosevelt African Expedition, in British East Africa, from the intestine of a bustard, *Neotis caffra*. The worms are characterized particularly by the presence of ten to twelve rows of very numerous hammer shaped hooks on the rostellum. Parauterine organs are present in gravid segments. The complete paper will appear in a forthcoming publication of the Smithsonian Institution.

Mr. Hall presented the following notes:

The Coyote as a Host of Multiceps multiceps

Curtice in 1890 first suggested that the adult gid tapeworm might occur in the coyote. In 1910 Hall noted the likelihood of this being true and pointed out that if it were true, then the most essential step in the prophylaxis of gid was the destruction of the heads of sheep dying of this disease, since the other prophylactic measure which is commonly advocated, the administration of tapeworm medicines to dogs, is obviously inadequate if coyotes also carry the parasite. In another article in the same year Hall noted that we had absolutely no evidence as to whether the coyote carried the adult worm, and that the only known host is the dog. The data regarding the blue fox and red fox as hosts of the gid tapeworm are quite inadequate and these animals must be considered doubtful hosts on the evidence at hand. There is no record of any sort as regards the wolves, martin or polecat, all of which have been noted as possible hosts.

To settle the question as to whether the coyote carried the adult gid tapeworm, a matter of considerable interest in that the coyote is the most common of the wild carnivora which prey upon western sheep, the experiment was tried of feeding the larval *Multiceps multiceps*, recovered by operation from the brain of a giddy sheep, to two coyotes. The sheep was operated on April 4, 1911, and the cœnurus was fed to the coyotes shortly after the operation, each animal receiving about half of the cyst. One coyote was found dead the morning of April 10. Post mortem examination showed death to be due to septicæmia. The entire length of the small intestine showed severe ecchymotic hemorrhage. Fifty two heads of *M. multiceps* were recovered from the intestinal contents. A comparison of these worms after six days' development with some recovered from a dog after ten days' development shows the worms had established themselves and were developing normally. They were still very small, of course, but there is no reason to suppose that they would not have developed to maturity if the coyote had lived.

The coyotes, *Canis nebracensis*, according to Dr. Bailey, of the Biological Survey, were obtained in northern Montana in the area where gid is enzootic and the coyote, therefore, must be considered, in view of the experimental findings, as sharing with the dog the responsibility for carrying the gid parasite and maintaining the gid disease in that state.

A Third Case of Multiceps serialis in the Squirrel.

In a list of occurrences claimed for the larval *Multiceps serialis*, Hall in 1910 noted that Cobbold in 1864 had recorded *M. serialis* under the name by which it is more commonly known, *Cœnurus serialis*, from an American squirrel in England, the host being specified in a later article by Cobbold in 1879 as probably *Sciurus vulpinus*, and that Cagny in 1882 had recorded a second case from the squirrel, *Sciurus vulgaris*, in France. Hall accepted these records as probably correct. It was a fair assumption that Cobbold's cœnurus would be the same species as that found in another rodent, the rabbit, rather than the species found in the sheep. He did not specify whether the American squirrel was merely an American species or the animal in question was actually from America. If it was infected in America at that date, it would be much more likely that the parasite was *M. serialis* than *M. multiceps*, as the latter form is much the more rare and limited in distribution now and probably was even more so then. Kunsemuller, in an article in 1903, thinks this cœnurus of Cobbold's was probably *M. serialis*. Cagny found his cœnurus in a squirrel which had been caught young and kept three years. His specimen was examined by Mégnin and Railliet, both of whom pronounced it *Cœnurus serialis*.

In the article already noted, Hall stated that it was to be expected that a parasite like *M. serialis*

would be rare in a host like the squirrel, as the squirrel's food is of such a nature, consisting as it does largely of nuts, that fæcal contamination by carnivorous hosts of the adult worm would only occur very rarely.

Recently the writer has produced the larval *M. serialis* in an American squirrel, *Sciurus carolinensis*, by feeding proglottids of the adult worm from the dog. This proof that the squirrel may act as host of *M. serialis* warrants us in accepting Cobbold's and Cagny's cases without reservation.

The squirrel was fed December 29, 1910, with fifteen proglottids collected eight days before from the fæces of a dog infected with the adult *M. serialis* by feeding the larval form from the rabbit. The proglottids had been kept in water from the time they were collected. Superficial examination indicated that some of the proglottids were gravid and some were not. As the proglottids were injected into the mouth the squirrel stored part of them in the cheek pouches, but it was certain that the rotten proglottids would release some of the eggs and that these would be swallowed even though the proglottids might be rejected later. Ninety-two days after ingesting the proglottids, the squirrel died. It had been active up to two or three days before death and had then remained down, clawing at its jaws occasionally. Before the skin was removed, the swellings on the abdomen, back and legs plainly showed the presence of the parasite cysts. After skinning the animal, the cysts were found on the lower abdomen, the middle of the back, the right shoulder and side, the right hind quarter, the left thigh, the left hind quarter, the left calf and the left breast, side and shoulder. An incision along the abdomen did not disclose any on the viscera. The thorax was not opened, and the specimen was preserved intact except for two cysts which fell out from a superficial position under the skin on the abdomen. One of these was cut in two and both cysts were put in the ice box at a temperature of 12 to 14° C. for 44 hours. At the end of that time they were immersed in warm water. The one which had been cut in two showed no sign of movement and was apparently dead. The other cyst, which had been punctured and lost a large part of the contained fluid, showed the contractile movements characteristic of bladder-worms and was cut in two and fed to two dogs.

The cysts showed the linear arrangement of scolices which is often found in *M. serialis* and from which the species takes its name. The identification of the parasite in this case is based less on this, however, than on the fact that it was produced by feeding the adult worm.

The secretary read a paper by Mr. Foster entitled "Some Experiments in the Development of *Tænia tæniæformis* (Bloch, 1780) Stiles and Stevenson, 1905, with an Account of Coccidiosis in the Cat." By feeding experiments the larval parasite was developed in the rat from the cat tapeworm and the cat tapeworm developed in turn from these larvæ. Attempts to infect dogs failed. Some differences were found in the larval and adult hooks. In general the results agreed with those of earlier experiments. A coccidium found in the cat proved to be much larger than *Coccidium bigeminum*, the only form hitherto reported from the cat. It resembled *Eimeria stiedæ* in size but differed from it in the piriform shape of the oocyst and the absence of residual protoplasm.

Dr. Garrison gave a demonstration of a new intestine tray for autopsies. This consists of a copper sheet 30 inches long, 10 inches wide at the broad end and 5 inches wide at the narrow end, with a raised edge an inch and a half high, and with a steel rod attached to the raised edge where it is prolonged along the broad end and running above the tray to the narrow end where the rod rests on the body of the tray, the end of the rod curving downward over the narrow end of the tray. At the ends the tray is bent down to form vertical supports 6 inches long at the wide end and 4 inches at the narrow end. The floor of the tray is convex upward, the middle being about an inch higher than the sides. In use the tray is placed over two pails or jars with a slight slope downward toward the narrow end, or else the tray is stood up in two shallow dishes, the slope being obtained by virtue of the greater length of the vertical support at the broad end.

The intestines are placed in the jar or other receptacle at the lower narrow end of the tray and one end of the intestine is pulled up on the steel rod. The section of intestine held by the rod is then cut open and falls on the floor of the tray where it can be examined and washed, the contents going into the lower jar. When one section of intestine is examined it is placed in the upper jar at the same time that a fresh section is pulled on to the rod. The size of the rods varies with the size of the animals examined. To facilitate detection of parasites the tray should be painted or enameled black. The tray can be easily cleaned and sterilized.

MAURICE C. HALL,
Secretary

SCIENCE

FRIDAY, JUNE 30, 1911

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THE PURPOSE AND SPIRIT OF THE UNIVERSITY[1]

MODERN students of human nature have changed the old saying, "Many men, many minds," into the new dictum, "One man, many selves" There is much talk of multiple personality Our complex modern life reflects itself in a composite person A man is said to have as many selves as there are social groups of which he feels himself a member To maintain a business self which can look a moral self straight in the eye, to have a theological self on good terms with a scientific self, to keep the peace between a party self and a patriotic self, to preserve in right relations a church self and a club self—such are the present problems of many a man or woman One way to escape embarrassment is to invite at a given time only congenial and harmonious selves, and to banish from the company the selves that are discordant and disconcerting The strong soul is he who can summon all his selves into loyal team play. Personality is the name men give to this unity of the self, and purpose is the organizing principle. Only as many groups of thought and feeling are schooled into cooperation by a well-considered, steadfast aim can a man be master of a single self. To be sure, unity of a sort can be achieved by one who has a meager company of selves Narrowness, provincialism, bigotry, describe a personality in which unity of purpose is won at a sacrifice of breadth, outlook and sympathy The highest type of personality grows out of many far-reaching selves which have

[1] Commencement address of the president at the University of Wisconsin.

been selected and organized into unity by a dominant purpose. It is no easy task to unify often divergent and conflicting impulses, habits, memories and ideals into a harmonious hierarchy of aims. But such singleness of ideal and effort creates power. The man of purpose is not to be resisted. Every instinct and habit, every picture of the mind, every effort of the will, every emotion, fits into his scheme of things. He never wanders from the path which leads toward the end he has set up. He turns every opportunity to account. He foresees problems and is prepared to meet them. He confronts difficulties undaunted. He is master of a company ever devoted and responsive to command. The world submits to great men of single aim.

Education seeks just this unification of personality. Plato's philosopher was he in whose life reason aided by will kept appetite and passion in servitude to the higher aims of life. Sir Richard Jebb tells us that

> Education consists in organizing the resources of the human being. It seeks to give him powers which shall fit him for his social and physical world. . . . The educated person is able to deal with circumstances in which he has never been placed before. He is so because he has acquired general conceptions. His imagination, his judgment, his powers of intelligent sympathy, have been developed.

The ideal personality, then, includes many selves organized by a masterful purpose and unified by a spirit of harmony.

In many ways a human group, a family, a community, an institution, a nation, is like a personality. Hobbes saw the state as a vast Leviathan. Comte conceived humanity as an on-going continuous life which sweeps through the centuries. Bluntschli endows political society with the characteristics of a person. Contemporary philosophers attribute to society the mental and moral traits of a vast super-man. The analogy is not wholly fanciful. Just as purpose unifies the individual, so a common aim gives the human group a sense of solidarity. Social consciousness is the well-worn term for this thrill of comradeship. The sense of team play that makes the eleven or the nine an efficient unit gives us the type. Each individual sees the group as a whole, is aware of his own relation to it, knows that his fellows share his feeling, and counts upon them to act promptly for a common end. A group which can not control its members and rally them in loyalty to a single aim lacks solidarity and effectiveness.

So, too, a large inclusive group like the nation must subordinate the minor groups that make it up, must rally them to the service of the whole, must provide the ideals and the plans for gaining a national end. The story of modern Germany is eloquent of imperial purpose and of aims unswervingly pursued. Contrast the broken, humiliated German states after the battle of Jena with the unified, efficient triumphant empire of to-day. The names of von Stein, von Moltke and Bismarck spell purpose and policy, far-seeing, statesmanlike, remorselessly followed. These aims seem like vast independent forces, molding men and institutions to their service. Schools, army discipline, scientific research, technical skill, commercial resourcefulness, governmental efficiency, social legislation, are all well considered parts of one comprehensive, far-reaching national program. Against such a power a disorganized, untrained and undisciplined nation is impotent. The law of unification through purpose holds good whether the units be the impulses, thoughts and feelings of the individual, or the persons and groups that make up a great people. As we classify the powers

of the world we may value them for their contributions to the past, but their futures we measure in terms of social unity and national purpose. To a despondent observer our own nation at times appears to lack both unity and a clear vision of its task. Sections, classes, interests, parties, cliques, sects seem to the gloomy onlooker to give the lie to the idea of national unity. Faith in a glorious manifest destiny is not the same thing as a real sense of national purpose. But beneath all the discord and clash of antagonistic groups, and vaguely emerging from a fatalistic optimism, we discern an underlying loyalty to American ideals and a clearer conception of American aim and American duty. Our national greatness will depend upon the growth of loyalty and good will, and upon the working out of an ever clearer conception of America's part in the building of a nobler civilization.

As with the nation, so with the institution. Consciousness of itself, a sense of team play, loyalty to a common aim, make a university strong and efficient. But the university gets its meaning from society and from the nation and therefore must be an expression of the common life. In the words of Dr. Pritchett, "No nation is likely to be educationally efficient until it has grown into some fair possession of a national educational consciousness." The university is one of the agencies of national purpose. "The kings," writes President Jordan, "have recognized the need of universities and university men. In this need Alfred founded Oxford, and Charlemagne the University of Paris. The Emperor William is quoted as saying that 'Bismarck and von Moltke were but tools in the hands of my august grandfather.' To furnish more such tools and in all the range of human activity, the University of Berlin was established."

If the university, as an organ of society, is to gain strength of purpose it must have a consciousness of its function and duty. Only by such sense of team play can individuals, departments, schools, colleges, faculties, classes, student groups, be fused into genuine unity and rallied to a common loyalty. In general, the university ideal is changing from the thought of personal privilege to the conception of social service, from a preaching of personal culture to a democracy of studies, or in another phrase, from culture to efficiency. This does not mean that colleges and universities have not always had some sense of social obligation. But too generally the privileges of higher education were for the favored few who by virtue of their special opportunities were set off from the masses of men. The growth of democracy has made new demands, has widened opportunity, has broken down the barriers of class. Even in the old world, and notably in the new, democracy has created schools, colleges and universities and has chartered them to serve the common welfare. The university has become, therefore, especially in this mid-western region, "the people's organized instrument of research," or as President Van Hise puts it, "the scientific adviser of the state." On every hand we hear variations of this central theme of social service. College presidents and men in political life, each group from its own point of view, insist upon this conception of higher education. In this view the university appeals to the imagination, it becomes an organ of the higher life of the community and the state, it connects itself at every point with the industry, commerce, social conditions, educational interests, ideal purposes of the commonwealth.

The university as a social agent is entrusted with certain standards of the community, standards of scientific method and

of truth, standards of technical efficiency, standards of cultural attainment, standards of personal character and of civic duty. It is only through the creation, the guarding, the elevation of these standards that material and spiritual progress is possible. The university becomes a trustee of ideas and ideals, a custodian of standards In the administration of these standards the university can not sacrifice the common welfare to individual need or desire It must exclude those who fail to meet the standards of attainment and character which the university administers Favoritism, faltering, compromise, cowardice mean betrayal of a social trust Nor may the standards of the university be provincial and temporary In the words of President Hadley, "the university must be judged by the standards which have held for all time rather than those of a single generation, or of a single profession" The imagination kindles at this thought of a university exalting the tests of truth and character by which society slowly gropes toward higher levels

When the mind is possessed by this vision of the university, all the careers for which it provides training take on the dignity of social worth. Vocations which have been thought of as individual widen into literal calls to be servants of the common life The office of the teacher, the function of the physician, the work of the engineer, get their higher meaning from their value to the community. The profession of the law, so often thought of as a field for personal exploitation, is in its true significance a social service. "We lawyers," declares Woodrow Wilson, "are servants of society, officers of the courts of justice . . . guardians of the public peace, . . . bond servants of the people." The scientific farmer is in one view seeking personal gain, but in a much deeper sense he is diffusing knowledge and skill and is raising into higher esteem fundamental industry which makes modern society possible The college graduate who has received the training men are fond of calling liberal, may no longer regard himself merely as a member of a privileged class. In the new spirit of *noblesse oblige* he must recognize his obligation to his fellows and to the community, must remember that "life is not a cup to be drained, but a measure to be filled" Such is the ideal purpose which summons the modern university to unity and comradeship in the service of the common life When this vision fills the minds of all, when it controls their conduct, when it stirs their emotions and carries them steadily forward to loyal achievement, then the university gains an irresistible power and becomes a true expression of the higher purposes of the state, the nation and mankind.

As a general purpose, a settled character, a dominant spirit control the thoughts and impulses of the person, so the persistent aim and the enduring ideals of an institution influence and guide the individuals who compose it. The trustees of a university that is unified by the purpose of service must think of themselves as public officers entrusted with grave duties and heavy responsibilities No personal ambition or interest can enter where the spirit of trusteeship for the common welfare is the controlling ideal. Strong, resourceful men may well sacrifice their personal interests in responding to so high a summons. To administer a university wisely, with open mind to the public welfare, with sympathetic insight into the needs and inspirations of all classes of citizens, to safeguard academic freedom, to guarantee positions of dignity and satisfying activity to competent scholars—these are the duties and

opportunities of men who accept a great educational trust

Devotion to the common good lays upon members of the investigating and teaching staff duties they may not shirk To maintain worthy standards of scholarship, to be loyal to these ideals, to be faithful to the pursuit of truth, to conceive education in its widest and most generous aspects, to have sympathetic insights into the lives of their students, to spend themselves freely for the community—to these things the vision of the university as a public servant must draw the teachers and the investigators of a true university This is the call to the "scholarship whose devotees regard themselves as holding a trust for the benefit of the nation"

The university fails of its purpose if its students do not catch the inspiration of the common ideal To generous-minded young men and women this thought of the university must make appeal It is the duty of the institution to fix this image of the university in the imaginations of its students. From the day they enter to the day they leave, this dominant purpose, this persuasive spirit should grow ever more potent and fascinating. It would be well if students could begin their college life with formal ceremony so that at the very outset they might feel more keenly the social obligations they are assuming Admission to the university should seem to them initiation into a high calling It is a pity that they should begin for the most part thoughtlessly or with minds fixed solely upon personal aims and plans. The state is calling them to her service. She has a right to insist that only those who are in earnest, who have at least a dawning sense of social duty, should seek admission to the public training which can be justified only by its service to the state. It should be made clear that no one has the right to demand admission as a personal privilege. Conformity with technicalities of entrance must not blind us to the moral obligations involved Out of the common fund to which all citizens contribute the state erects and maintains not for personal advantage but for public good this West Point of science, the arts and the professions Every matriculant, therefore, by virtue of admission is honor bound to meet the state half way in her desire to prepare soldiers of science for the battles of peace. The university must unhesitatingly rid itself of individuals who are indifferent to intellectual work or hostile to it After fair test, those who fail to show their sense of the university's purpose must be dismissed This is necessary not only in justice to the state, but in fairness to those who show due appreciation of their opportunities and duties

The dominant university purpose gives a proper setting to the activities of student life and to the standards and conduct of the groups into which the student community naturally falls. The contacts of daily association and searching tests of comradeship, the discovery and development of leadership, the give and take of social intercourse, the healthy recreation of undergraduate life—all constitute an environment which may afford admirable discipline There is large truth in the assertion that the university is the world in miniature and that it offers a social training which will be turned to account in the wider life of the community. But all these activities must be tested by the dominant purpose of the university. The question must always be, is this or that out of harmony with the ideal of the university as an organ of the common life? Does this student demonstration or that rollicking festivity create in the public mind the feeling that the university is living for itself

and not for the community, does it foster the belief that the university is not dominated by the motive of service, does it create the suspicion that students ignore or forget their duty to the state which is making their self preparation possible? This is a vital question. So with the student groups that play so large a part in academic communities. Are these groups working loyally for the common welfare, have they due regard for the fundamental things of university life, are they actuated by a sense of responsibility for their members, do they cultivate tolerance, justice and good-will? These are questions which individuals and groups must constantly put to themselves and answer frankly and honestly. The good name of the university is safe only when its members feel an obligation to further the common purpose to make the university a true organ of the whole people.

So long as this spirit prevails, no sense of arrogance, of exclusiveness, of privilege or caste will enter the minds of its members. The old distinction of "town" and "gown," the traditional attitude of superiority toward those outside the walls of the academic cloister, these things have no place in an institution dominated by the spirit of social service. Every man and woman of the commonwealth becomes in this view a supporter and patron of the university, and may expect from it good-will and loyal service. If to say that the university belongs to the state is anything more than phrase-making, every member who has imagination, the power to see the institution in its real relationships, must feel the genuine humility of one who would faithfully serve his fellows.

If the university is to fulfill its function, it must carry conviction to the people of the commonwealth. It must impress them with its purpose, make them see it as a faithful agency of the people. The men and women of the state must not think of the university as an institution which, because it has public support, should lower its standards to admit the weak, indifferent or incompetent, or to graduate those who have failed to reach the minimum of attainment. People must not think of the university as a place in which personal influences can secure special privilege. Rather they must regard it as fearlessly loyal to the common welfare, true to high standards of scholarship, truth, efficiency, character and judgment. They must not ask or expect special favors from this servant of the whole democracy.

If the university purpose is to be achieved the institution must seek special ability wherever this is to be found. It would be a calamity if only sons and daughters of the rich and well-to-do could gain access to higher training. Talent and genius ignore the distinctions of wealth and class. A way must be found by which young men and young women of great promise, however they may be hampered by poverty, may gain access to the social training of the university, and be freed in large part or wholly from the self-supporting work which makes the best scholarship impossible. We must believe that men and communities will catch this vision of the university and by providing scholarships see to it that no exceptional ability shall be deprived of development for the service of the commonwealth. The university would lose its power and its ideals if it ever became a place of privilege for the well-to-do and not a training school for all who have talents and capacities for which the state has need. The controlling ideal, the mastering purpose of the university, therefore, is not a mere phrase or conceit, it is a guiding principle which finds application to every individual, to every group,

to every activity of academic life, and organizes these into the strength and unity which only a common aim can confer

Purpose steadily pursued creates a persuasive spirit, registers itself in institutional character Open-mindedness must be a conspicuous trait of a true academic community The very search for new knowledge, the effort to see the relations of things, presupposes an attitude of enquiry, a willingness to look at an idea or a fact from many different standpoints Open-mindedness toward truth merges into tolerance and mutual respect as between the individuals and groups who make up the university Narrowness or prejudice, a patronizing attitude of one group toward another, the discrediting of this calling as compared with that, the limiting of the conception of research to traditional fields of enquiry—these things have no place in an institution mastered by a sense of loyal duty to commonwealth and nation Genuine culture consists largely in sympathy with many kinds of men and in insight into the widest ranges of human life To live in a highly specialized community and to enter with appreciation into the activities of one's colleagues in many fields is in itself a liberalizing experience There is place for generous rivalry in a great university, but this rivalry must be kept on a high level and not allowed to sink into unworthy conflict and discord Open-mindedness, tolerance, high-minded rivalry can not fail, under the guidance of a controlling ideal, to fuse the university into a genuine unity of comradeship and good-will. When each man and each group can see, not only through its own eyes but through the eyes of other persons and groups, the common problems of the institution, there must develop a keener sense of team play, a quickened loyalty, a more vivid corporate consciousness

The university, a servant of the common life, exalting standards of efficiency and worth, summoning its members to a common task, must stand for the loftiest ideals It must inspire enduring faith It must exalt character above technical skill, mental alertness, refinement of feeling It must lay hold of the fundamental motives. The university rightly aims at leadership, but in the words of Dr Pritchett, it can win this "only by inspiring the youth of the democracy with a true, vibrant living faith The American university is today the home of that faith It is the faith of humanity in humanity and the American university, which embodies the intellectual aspirations of a free people, is becoming day by day the representative of their spiritual aspirations as well " The state university can not fulfill its true function unless it rises to the higher level of spiritual idealism It may not ally itself with any church or support any one theology, but it must draw its inspiration from an essentially religious view of life As the Sir Thomas More's Utopians tolerated many theologies of widely varying kinds, but united in common worship of the divine energy back of all nature and human life, so the university welcomes men and women of many faiths and rallies them to a devoted loyalty to common ideals of duty, service and reverent aspiration

In the "Republic" Socrates, in talking of testing the young for leadership, declares, "We must inquire who are the best guardians of their own conviction that the interest of the state is to be the rule of all their actions We must watch them from their youth upwards and propose deeds for them to perform in which they are most likely to forget or be deceived, and he who remembers and is not deceived is to be selected, and he who fails in the trial is to be rejected." The gentle sage goes on to

describe the tests of toil and pain, the tests of fear, the tests of seductive pleasures, and he tells us that "He who at every age as boy and youth, and in mature life, has come out of the trial victorious and pure, shall be appointed a ruler and guardian of the state. He shall be honored in life and death, and shall receive sepulcher and other memorials of honor, the greatest that we have to give."

The essentials of life and character have not changed since the days when Socrates talked of truth and justice in the groves of Academus. You graduates to-day go forth to be tested. You have in varying measure the vision of the university, the sense of obligation which your training lays upon you. You must hear, be it ever so faintly, the call to be servants of the commonwealth. Put to yourselves the question which comes down through the centuries, can you hold to this conviction that the interests of the community should be the rule of all your actions. You will face intellectual sophistry and beguiling fallacies. Have you the keenness of mind and the force of character to analyze these specious assertions and to hold steadfastly to things that are true and enduring? You will be tested by fear, fear of financial loss, fear of ridicule, fear it may be of social ostracism. Have you the courage and character to preserve your convictions of loyalty to the general good? You will be lured by pleasure, dazzled it may be by luxury and ostentation, tempted to self-indulgence and evanescent pleasures. Have you the fiber to resist these appeals and to remember that the social servant must be ever strong, clear eyed and faithful to his work?

May you hold to the vision you have caught: may it with the passing years grow ever clearer, brighter, more commanding in your lives. The university sends you forth to-day with God speed, entrusts to you the good name of our widening community, summons you to loyalty, urges you to organize all your resources of mind and spirit into the unity of a high aim, the firm resolve to realize in your own lives the masterful purpose of the university which is to be in ever fuller measure at once the standard bearer and the servant of the state.

Go to your work and be strong, halting not in a world of men,
Balking the end half won for an instant dole of praise.
Stand to your work and be wise—certain of sword and pen,
Who are neither children nor Gods, but men in a world of men.

GEORGE E. VINCENT

COURSES IN HIGHER PURE MATHEMATICS

THE number of the objects of mathematical thought is infinite and the rapidly widening range of developed mathematics is continually directing mathematical attention to objects which were previously either practically or entirely ignored. Efforts to classify mathematics have been only partially successful and it is extremely difficult, in many cases, to draw reliable conclusions as to the nature of a course from its title. Hence the efforts to ascertain from the announcements of the leading universities of the world the relative emphasis which different countries place on the various subjects of higher mathematics can not be expected to lead to entirely trustworthy results.

The rapid development of our universities has led to such a rapid increase in the number of different mathematical courses beyond the first courses in differential and integral calculus, that many well-educated people have failed to keep informed as regards the general meaning of the titles of some of these courses. This is perhaps not surprising in view of the fact that several of our strongest universities offer their advanced courses under more than thirty different titles.

This great number of titles of courses implies that many of them are devoted to comparatively narrow fields and raises the question whether we are not in danger of specialising too much and of depriving our students of a thorough training in the more general and fundamental methods of wide contact. It would probably be generally conceded that we have gone further in the line of special courses than the universities of Germany, which were pioneers in this direction. On the other hand, it may be observed that the large German and French mathematical encyclopedias which are in the course of publication treat pure mathematics under about one hundred general headings, each of which would be sufficiently extensive for a course suitable for graduate students.

This great extent of available material makes it impossible for one student to cover even superficially the entire field during his college days and hence it tends to increase his interest in a wise choice of his courses, especially as regards such courses as are most generally given and are most likely to be very useful in his later mathematical development. One of the most reliable sources of information along this line is furnished by the number and the extent of the courses devoted to different subjects in the various leading universities.

Various journals, including the *Bulletin of the American Mathematical Society*, are publishing, from time to time, lists of announcements of the courses offered by a large number of different universities of Europe and America. A comparative study of these announcements for a period of years involves a large amount of labor in view of the changes from year to year and the uncertainty as to the real significance of some of the titles. As American mathematical activity has been so largely influenced by Germany, especially during recent years, and as the University of Berlin occupies such a prominent place among the greatest centers of learning, it may be fitting to begin with some results drawn from the announcements of this university during the last six years.

The following table gives only those courses in pure mathematics to which the equivalent of at least twelve lecture hours for one semester have been devoted during the last six years. A large number of special courses have thus been excluded. For instance, one of the courses offered only once during the period covered by the table bears the title, "Transcendental Nature of π and e," another is announced under the title "Influence of Euler's Work on Modern Mathematics," while still another bears the title "Problems in Maxima and Minima treated by Methods of Elementary Geometry." No course bearing the title "Differential Geometry" was offered at Berlin during the period under consideration, and only one course entitled "Linear Substitutions." A large part of the subject matter of such courses was, of course, given in the courses under more general titles. Similar remarks apply to a large number of other subjects. The number of hours devoted to seminars and colloquia was not included in the following table as the subject matter of these exercises was not always clearly announced.

BERLIN UNIVERSITY

Subjects	Lecture Hours for Six Years	Totals
Curves and surfaces	4, 11, 8, 8, 8, 13[1]	52
Theory of functions	4, 6, 0, 8, 10, 12	40
Determinants, theory and applications	4, 8, 4, 4, 8, 6	34
Theory of numbers	4, 4, 8, 8, 4, 2	30
Elliptic functions	4, 4, 4, 8, 8, 2	30
Algebraic equations	0, 4, 8, 4, 6, 4	26
Differential equations	0, 4, 6, 4, 6, 4	24
Algebra	4, 4, 0, 4, 0, 4	16
Calculus of variation	0, 4, 4, 0, 0, 4	12

It may be observed that the total number of hours devoted to the four subjects belonging to arithmetic and algebra is 106, while the total numbers of hours devoted to analysis and geometry are 98 and 52, respectively. As we shall see later, these results are not in accord with those obtained in a similar man-

[1] The last of these numbers applies to the current year, and the numbers which precede relate to the preceding years in order.

ner from many other universities and they would be slightly changed at Berlin if all the courses in pure mathematics had been tabulated. They would also have been affected by the consideration of the courses on applications of mathematics. As is well known, a large number of courses on applications of elliptic functions are given at Berlin. These are in addition to the courses on the theory of these functions as listed above, and during the six years under consideration the number of lecture hours devoted to these applications in Berlin University were, respectively, 6, 0, 10, 0, 8, 4—making a total of 28. Hence a total of 58 lecture hours for a semester were devoted to elliptic functions and their applications during these six years—an average of nearly five hours for each semester.

Among the other German universities which maintain very strong mathematical departments Gottingen should perhaps be especially mentioned in view of the facts that so many Americans have studied there and the influence of Klein and Hilbert has been so great in shaping our courses in higher mathematics. It may also be desirable to bring the mathematical courses of the universities of Berlin and Gottingen together in view of the fact that they exhibit a great difference as to emphasis on the various subjects of pure mathematics. For instance, only two courses on determinants and their applications were given at Gottingen during the last six years while at Berlin this course has been given very frequently, as may be seen from the table given above.

At Gottingen courses on differential equations have been given very much more frequently than at Berlin, while courses on elliptic functions are much more common at the latter institution than at Göttingen. Judging from the number and the extent of the courses, there is a very wide difference between Berlin and Göttingen as regards the emphasis on the subjects which are usually classed under the general headings, algebra and analysis; or arithmetic and algebra, and analysis. At Berlin the former receive very much more attention than at Göttingen and the predominating influence of the latter institution is evident in the advanced mathematical courses of many American universities. A marked difference between Gottingen and Berlin may also be observed with respect to the tendency to give courses under a large variety of names. At Gottingen we find a larger number of courses under such titles as, encyclopedia of geometry, encyclopedia of elementary mathematics and elementary mathematics from a higher standpoint, than at Berlin.

In the following table we give again only those courses to which at least twelve lecture hours for one semester have been devoted during the last six years, excluding courses which appeared to have been devoted mainly to applications, and arranging the others in the order of the number of lecture hours.

GÖTTINGEN UNIVERSITY

Subjects	Lecture Hours for Six Years	Totals
Differential equations	12, 12, 12, 8, 11, 4	59
Theory of functions	7, 0, 8, 6, 10, 8	39
Descriptive geometry	4, 4, 0, 8, 0, 8	24
Algebra	4, 0, 4, 4, 4, 4	20
Theory of numbers	4, 0, 2, 4, 3, 4	17
Calculus of variations	4, 4, 1, 4, 0, 2	15
Curves and surfaces	7, 4, 2, 0, 0, 0	13
Principles of mathematics	0, 0, 4, 2, 2, 4	12

A comparative study of the courses offered in other German universities reveals wide differences as regards emphasis on the various subjects and such a study tends to explain the migration of students from one institution to another. Unfortunately, there is very little migration in American universities, and hence our students are frequently acquainted only with the courses offered by one institution. This makes it the more desirable that our large universities should aim to offer a wide range of subjects, covering the most important parts of the various developed fields of mathematics. It is evident, however, that it would be much better if our students could be induced to divide their time of graduate study among different universities and to seek instruction under the foremost men along the lines of their chief interests.

It is of great interest to consider the difference between the emphasis placed on various subjects by different countries A comprehensive study of this difference becomes, however, quite difficult in view of the fact that the different countries vary widely as regards the line of division between their university courses and those treated earlier It is, however, not difficult to establish certain decided differences A slight study reveals the fact that American universities are unusually weak, on an average, with respect to courses on elliptic functions, general mathematics and theory of numbers, while the relative number of our courses in the theory of groups, theory of functions, and differential geometry is above the average These results are deduced from a fairly extensive tabulation of the courses in mathematics which Professor J B Shaw recently presented before the Mathematical Club of the University of Illinois In particular, Professor Shaw listed the courses of all German universities for a period of six years and found that during this period the number of lecture hours devoted to courses in the three great fields of pure mathematics—algebra, analysis and geometry—were in the proportion 193, 259 and 200, respectively

G A MILLER
UNIVERSITY OF ILLINOIS

WILLIAMINA PATON FLEMING

MRS. WILLIAMINA P FLEMING, curator of astronomical photographs at the Harvard College Observatory, was born in Dundee, Scotland, on May 15, 1857, and came to this country soon after her marriage in early womanhood. She soon drifted into the work which was destined to occupy her life, by undertaking some simple astronomical calculations at the Harvard Observatory, where, upon her death on May 21, 1911, she had just completed thirty years of service These thirty years have covered a period of remarkable changes in the methods of attacking astronomical problems. The prism has revealed to us something of the nature of the heavenly bodies, and the photographic plate has made a permanent record of the condition of the sky, which may be studied at any time Celestial photography was systematically undertaken at Harvard in 1882, by Professor E C Pickering, the present director The work was placed on a firm basis by the liberality of Mrs Draper in establishing the Henry Draper Memorial, and in a short time, photographs were being taken in large numbers The Harvard photographic library now contains over 200,000 plates

Mrs Fleming's duties were to qualify these plates, superintend their care, examine them for peculiar objects, and make investigations by means of them Each plate must be so indexed that it can be found at any time, and must be carefully handled and stored, being of fragile glass, and without a duplicate With a naturally clear and brilliant mind, Mrs Fleming at once evinced special aptitude for this photographic investigation, which was so novel that precedents could not be found for its execution, and, in return, the photographs proved to be veritable mines of wealth for the extraction of information concerning the sidereal universe Most of Mrs Fleming's discoveries were made from the spectrum plates which are taken by means of a prism placed before the object glass of the telescope, and which often show the spectra of several hundred stars She examined with a magnifying glass, all these plates taken at Cambridge and at the Harvard southern station in Arequipa, Peru, and marked all objects showing any peculiarities in their spectra In this way, she found ten new stars and more than three hundred variable stars, because of the presence of bright lines in their spectra She classified the spectra of 10,351 stars, which were published in 1890 in a volume of the *Harvard Annals*, called the "Draper Catalogue of Stellar Spectra." When stricken with the fatal illness, she was at work on a Memoir on Peculiar Spectra, which will give useful tables and much additional information concerning many interesting celestial objects. Much of her time was always occupied by tedious work upon the proof of the numerous volumes of the Annals

published by the Observatory during the last twenty-five years. Her diligence and patience were combined with great self-reliance and courage. She was a member of the Astronomical and Astrophysical Society of America, and of the Astronomical Society of France. The British Royal Astronomical Society made her an honorary member in 1906, and soon after, she was appointed Honorary Fellow in Astronomy of Wellesley College. Only a few months ago, the Astronomical Society of Mexico presented her with a gold medal for her discovery of new stars.

She left one son, Edward P. Fleming, who graduated from the Massachusetts Institute of Technology in 1901, and is now a mining engineer in Chile.

Of a large-hearted, sympathetic nature, and keenly interested in all that pertains to life, she won friends easily, while her love of her home and unusual skill in needlework, prove that a life spent in the routine of science need not destroy the attractive human element of a woman's nature.

ANNIE J. CANNON

HARVARD COLLEGE OBSERVATORY,
CAMBRIDGE, MASS.,
June 3, 1911

SOCIETY FOR THE PROMOTION OF ENGINEERING EDUCATION

THE program of the Pittsburgh meeting on June 27, 28 and 29, is as follows.

TUESDAY. Meetings at the School of Applied Science, Carnegie Technical Schools.

At 9.45 A.M. Address of welcome by Director A. A. Hamerschlag and response by President A. N. Talbot.

"Teaching English in Technical Schools," Professor S. C. Earle, Tufts College.

"The Preparation of Written Papers in Engineering Schools," Professor F. N. Raymond, University of Kansas.

"The Use of Logarithmic Diagrams in Laboratory Work," Mr. H. A. Gehring, Department of New York State Engineer.

"Highway Engineering," Professor A. H. Blanchard, Brown University.

At 2:00 P.M. Report of Committee on Teaching Mathematics to Engineering Students, Professor E. V. Huntington, Harvard University.

"Balance of Courses in Chemical Engineering," Dean C. H. Benjamin, Purdue University.

"Chemical Education for the Industries," Professor J. H. James, Carnegie Technical Schools.

A visit to the Country Club, followed by a dinner tendered by Director Hamerschlag on behalf of the Carnegie Technical Schools. During the evening President A. N. Talbot delivered his presidential address on the subject, "The Engineering Teacher and his Preparation."

WEDNESDAY. Meetings at the School of Applied Science, Carnegie Technical Schools.

At 9.30 A.M. Report of the Committee on Entrance Requirements, Professor J. J. Flather, University of Minnesota, chairman.

"All year Session, Individual Instruction: Renewed Suggestions," Dean W. G. Raymond, University of Iowa.

"The Architecture of Engineering Schools," Professor J. M. White, University of Illinois.

"The Wentworth Institute," Director A. L. Williston, Wentworth Institute.

At 8.30 P.M. Executive session of the society and election of officers.

"The College Campus," illustrated lecture by Professor J. M. White, University of Illinois.

THURSDAY. Meetings at Thaw Hall, University of Pittsburgh.

At 9.15 A.M. Address of welcome by Chancellor S. B. McCormick and response by President A. N. Talbot.

"An Engineering Course for Underclassmen," Professors W. A. Hillebrand and S. B. Charters, Jr., Stanford University.

"Electrical Engineering Instruction," Professor E. B. Paine, University of Illinois.

"Teaching of Scientific Shop Management, with Use of Engineering School Shops as the Laboratory," Professors H. Wade Hibbard and H. S. Philbrick, University of Missouri.

"Technical Training from the Business Man's Standpoint," Mr. E. B. Raymond, vice-president of the Pittsburgh Plate Glass Co.

"Adapting Technical Graduates to the Industries," Messrs. C. F. Scott and C. R. Dooley, Westinghouse Electric and Manufacturing Co.

"Cooperative System of Engineering Education at the University of Pittsburgh," Dean F. L. Bishop, University of Pittsburgh.

At 8:30 P.M. Assemble in foyer of Carnegie Music Hall. The Pittsburgh alumni of engineering colleges were invited to meet the representatives of the faculties from their almæ matres. A brief program was rendered upon the organ

in Music Hall, after which the members visited the Department of Fine Arts and the Museum of the Institute

FRIDAY AND SATURDAY

Members are invited to remain in Pittsburgh after the close of the convention to make further visits among the industries described in the hand book Specific arrangements may be made for these visits at the secretary's office during the meeting Special arrangements were made for the benefit of visitors in a number of cases, notably the Bureau of Mines, the Jones & Laughlin Steel Company, the Mesta Machine Company, the National Tube Company, the Westinghouse Electric and Manufacturing Company and the Westinghouse Machine Company It is expected that engineers will be detailed to guide the visitors, and that, in some cases, special exhibits and tests will be provided

INDIANAPOLIS MEETING OF THE AMERICAN CHEMICAL SOCIETY

THE Indiana Section made special efforts toward an unusually successful meeting beginning June 27 and lasting throughout the remainder of the week. The program was arranged as follows

The council will meet on the afternoon of Tuesday, June 27, and after a business meeting will be taken for an automobile ride to the Indianapolis Speedway

On Wednesday, the general session will begin and three general addresses will be given Professor Charles Baskerville, of the College of the City of New York, will give an address on "The Chemistry of Anesthetics" Professor Edward Kremers, of the University of Wisconsin, will follow with a paper on "The Quinhydrone Hypothesis of Plant Pigmentation." The third address, by Professor W. Lash Miller, of the University of Toronto, will be upon "The Chemical Philosophy of the High-school Text-books" These papers will be followed by a complimentary luncheon at the German House and after luncheon meetings of the agricultural and food, industrial, organic and physical and inorganic divisions and the biological section will be held. In the evening a complimentary smoker will be held in the gardens of the German House.

On Thursday morning there will be meetings of the agricultural and food, industrial, organic, pharmaceutical and physical and inorganic divisions, one of the special features being the meeting of the pharmaceutical division in the new science building of the Eli Lilly & Co, followed by a luncheon there to the pharmaceutical chemists. At the same time a complimentary luncheon will be given to the remaining chemists at the Indianapolis Brewing Co, followed by an inspection of their plant In the afternoon all of the chemists will visit the plant of the Eli Lilly & Co On Thursday evening there will be a public lecture by Mr. A D Little at the German House on the "Earning Power of Chemistry" This lecture is one of the features of the meeting and is intended to interest chemists, business men and the general public alike. Following the lecture there will be a concert in the gardens of the German House

On Friday there will be an early visit to the Indianapolis Water Works followed by meetings of the fertilizer, industrial, physical and inorganic divisions and the sections of biological and of india rubber chemistry At 12·30 these will be followed by a complimentary luncheon at the automobile factory of Nordyke & Marmon, followed by an inspection of their factory. Later in the afternoon visits will be made to the Encaustic Tile Co., to the Fairmount Glass Works and to E C. Atkins & Co In the evening the usual banquet of the summer meeting will be held

On Saturday there will be visits to the Kingan & Co, Ltd., to the Polk Sanitary Milk Co and to the Diamond Chain Co., in the afternoon, to the Van Camp Packing Co.

A special endeavor is also being made to see that the ladies accompanying members have an enjoyable summer outing, including automobile rides, receptions, theater parties and luncheons.

Over one hundred and fifty papers have already been received for the divisional meetings.

CHARLES L. PARSONS,
Secretary

SCIENTIFIC NOTES AND NEWS

AMONG the honorary degrees conferred by Yale University are doctorates of laws on Dr Josiah Royce, professor of philosophy at Harvard University, and Dr George E Vincent, president of the University of Minnesota, the doctorate of science on Professor W. H Howell, professor of physiology in the Johns Hopkins University, and the doctorate of letters on Mr John Muir, naturalist and author

DR EDGAR F SMITH, provost of the University of Pennsylvania, has been given the doctorate of laws by Rutgers College

THE doctorate of science has been conferred by Wesleyan University on Dr F G Benedict, director of the Nutrition Laboratory of the Carnegie Institution and by Tufts College on Dr A P Wills, professor of mathematical physics in Columbia University

THE University of Pennsylvania has conferred an honorary doctorate of veterinary medicine on Dr. Veranus A Moore, of the State Veterinary Department of Cornell University.

BROWN UNIVERSITY has given a doctorate of science to Dr. H J Wheeler, director of the Experiment Station of the Rhode Island College, and the master of arts to Mr F E Seagrave, astronomer, of Providence.

PROFESSOR FRANKLIN W HOOPER, director of the Brooklyn Institute of Arts and Sciences, has received the doctorate of laws from Middlebury College

THE London Mathematical Society has awarded the De Morgan medal for 1911 to Professor H Lamb, F R S, for his work in mathematical physics.

MR LEONHARD STEJNEGER has been appointed head curator of the department of biology in the U. S National Museum to succeed Dr. F W. True.

THE board of scientific directors of the Rockefeller Institute for Medical Research announce the following appointments to the staff of the institute:

Alfred E. Cohn, M D., associate in medicine.

Arthur N. M Ellis, M B., assistant resident physician.

Alphonse R Dochez, M D, assistant resident physician

Frank W Bancroft, Ph D, associate in experimental biology

Reinhard H Beutner, Ing D, assistant in experimental biology

James B Murphy, M D, assistant in pathology

J J Bronfenbrenner, fellow in pathology

Frederick B La Forge, Ph D, assistant in chemistry

Henry K Marks, M D, assistant in pathology

Helen L Fales, research scholar in chemistry

Angelia M Courtney, assistant in chemistry

PROFESSOR F W SARDESON, of the department of geology of the University of Minnesota, has been appointed geologist on the U S Geological Survey He has been directed to complete the areal, stratigraphic, and glacial geology of Minneapolis, St Paul, Anoka and White Bear quadrangles and to prepare a folio descriptive of this region for publication

PROFESSOR HERBERT E. GREGORY, of Yale University, has gone to Arizona in the interests of the United States Geological Survey in order to continue his study of the water supply and economic resources of the Navajo Reservation. He will be assisted in this work by Professor W. R Barrows, Mr. K C Heald, of Colorado College, and Mr H F Robinson, irrigation engineer of the Indian Service.

THE International Seismological Association will hold its regular meeting in Manchester, England, from July 18 to 22 The United States is a member of this association, and will be represented at the meeting by Professor Harry Fielding Reid, of the Johns Hopkins University

DR. L. MURBACH, head of the department of biology in the high school of Detroit, Mich, has been given a year's leave of absence. His address will be Castleton, Vermont.

DR JOHN MILNE, F.R.S., has been appointed Halley lecturer at Oxford for the year 1912.

ON June 13, Professor Ernst Cohen, of the University of Utrecht, gave an illustrated lecture before the Faraday Society on "Allotropic Forms of Metals." Professor T. W.

Richards, of Harvard University, was invited to take the chair

DR I W BLACKBURN, professor of pathology in the Georgetown Medical School, and of morbid anatomy in the George Washington University, and for twenty-seven years pathologist in the Government Hospital for the Insane, died on June 19, aged 60 years

THE United States Civil Service Commission announces that the Philippine government desires to fill two vacancies in the position of chemist, division of organic chemistry, Bureau of Science, Manila, P I, at salaries of $2,000 each per annum It is desired to secure the services of two young men between twenty and forty years of age with a high grade of scientific training who are capable of original work A thorough training in general and organic chemistry at a reputable college or university and experience in organic research is a prerequisite for consideration for this position, a Ph D degree from a leading university would be preferable A certain share of the routine work for the government would devolve upon the persons appointed to these positions, but the history of the laboratory in the past has shown that each man has had ample time for himself to do research work. In general, the men would select their own topics for investigation, such topics, of course, to have some bearing upon the development of the Philippine Islands. Facilities for immediate publication of research work are found in the *Philippine Journal of Science*, which represents the Bureau of Science before the world The attention of persons well trained and experienced in organic chemistry is especially invited to these vacancies since, if persons of the desired qualifications are secured, the prospects of promotion for both will be good, as one will probably succeed to the position of chief of the division of organic chemistry at $3,000 per annum within a year or two As applications for this position will not be received after August 1, 1911, those interested should communicate with the U. S Civil Service Commission at Washington, D. C, before this date

IT is announced by Dr Edgar L Hewitt, director of American archeology for the Archeological Institute of America, that the valuable library of the late German linguist, Professor Franz Nikolaus Finck, is to be brought to this country It has been purchased by the Hon Frank Springer, of New Mexico, for the use of the School of American Archeology, the research school of the Archeological Institute of America The library is to be installed in the historic palace at Santa Fe, where the Museum of New Mexico and the School of American Archeology are now housed

AT the Field Museum of Natural History, several new groups of American mammals have been placed on exhibition. The prong-horned antelope is shown by five animals in a setting of agaves, cacti and other vegetation of the arid southwest with a large painted background showing other natural features Four groups of small mammals include the white-footed mouse, jumping mouse, meadow mouse and short-tailed shrew. These are grouped, respectively, on the four sides of a reproduction of a bit of woodland with logs, bushes, grass and flowers so arranged as to form an effective and characteristic background for each

THE Sproul Observatory was dedicated at Swarthmore College on June 6 It has been presented by Senator William C Sproul, as a memorial of the twentieth anniversary of the class of '91, of which he is a member The exercises consisted of the address of presentation, in behalf of the class, by Congressman A Mitchell Palmer, '91, the unveiling of the tablet by Miss Dorothy Sproul, daughter of the donor, the speech of acceptance, by Dr John A Miller, professor of mathematics and astronomy, an address by Miss Susan J. Cunningham, formerly in charge of the same department, and a poem, "Watching the Stars," written for the occasion, by J. Russell Hayes The new observatory is expected to be ready for use next fall The telescope, the lens of which will have a diameter of 24 inches, will be one of the most effective on the Atlantic coast

An expedition to southeast Arabia has been planned by the Danish Royal Geographical Society, the object being the mapping of parts of Oman and the studying of the ancient memorials and commercial prospects of the country.

A cablegram has been received at the Harvard College Observatory from Kiel, stating that Wolf's Periodic Comet was observed by Professor Max Wolf at Heidelberg, June 19, 1911, 4792 m.

R A $18^h 46^m 16^s$
Dec $+ 13° 28'$

The comet is visible in a large telescope

The second annual midsummer State Farmers Institute will be held at the University of Illinois on Tuesday, Wednesday and Thursday, July 11, 12 and 13 The attendance at last summer's institute was about 2,500. Addresses to the general session will be given by the following:

Hon J K Dickinson, secretary, State Board of Agriculture, on "Agricultural Advancement"

Professor J H. Skinner, dean of the College of Agriculture, Purdue University, on "Rural Problems and Rural Progress"

Hon B F Harris, president of the Illinois Bankers' Association, on "The Banker Farmer, his Influence on Agriculture"

Dr Charles E Marshall, Michigan Agricultural College, on "The Farmer and the Scientist"

Hon W. E. Morse, assistant general manager, Chicago Northwestern R. R., on "Advantages of Closer Cooperation between the Railroads and the Farmer."

The following geologic investigation is being carried on in Oklahoma: Professor D. W. Ohern, of the University of Oklahoma, and Mr. Carl D. Smith, of the U. S. Geological Survey, are conducting cooperative parties in the Vinita and Claremore quadrangles in the northeastern part of the state. Professor C. H. Taylor, of the University of Oklahoma, is studying the igneous rocks of the Wichita and Arbuckle Mountains. Professor J. W. Beede, of the University of Indiana, has a party in the northern part of the state and will endeavor to trace out the Pennsylvanian-Permian contact from the Kansas line to the Arbuckle Mountains. Professor C. A. Reeds, of Bryn Mawr College, who has already spent four years in the Arbuckle Mountains, will continue his studies in the lower Paleozoic rocks of that region. The Ohern, Smith and Taylor parties are cooperative; being maintained by the U. S Geological Survey and the Oklahoma Geological Survey, the Beede and Reeds parties are under the direction of the Oklahoma Geological Survey The U S. Geological Survey, the Oklahoma Geological Survey and the Oklahoma State Board of Agriculture are cooperating in the endeavor to ascertain whether or not potash or other soluble salts are present in the western part of the state A number of deep wells are being drilled, under the direction of the state board of agriculture, in the Panhandle of Oklahoma, in the hope of finding artesian water. The federal Geological Survey and the Oklahoma Survey are paying the expenses of a man to collect samples at frequent intervals from these wells These samples will be analyzed for potash or other fertilizer material Mr. Chas R. Eckes has charge of the work

UNIVERSITY AND EDUCATIONAL NEWS

Princeton University has received gifts amounting to more than $100,000, of which $40,000 is for a lectureship in public affairs to be held by the Hon. George B. McClellan

Dr. Robert A. Harper, professor of botany, in the University of Wisconsin, has been elected Torrey professor of botany at Columbia University.

New appointments and promotions at the Johns Hopkins University are as follows: In the Philosophical Faculty· Harry F. Reid, Ph.D., now professor of geological physics, to be professor of dynamic geology and geography; John A. Anderson, Ph.D., now associate, to be associate professor of astronomy; Knight Dunlap, Ph.D., now associate, to be associate professor of psychology; J. Elliott Gilpin, Ph.D., now associate, to be associate professor of chemistry; William Kurrelmeyer, Ph.D., now associate, to be associate

professor of German; B Franklin Lovelace, Ph.D., now of the University of Alabama, to be associate professor of chemistry, Samuel O Mast, Ph D, now of Goucher College, to be associate professor of zoology, August H Pfund, Ph.D, now associate, to be associate professor of physics, Charles F Meyer, A B, now fellow, to be assistant in applied electricity, Chester N Myers, Ph D, to be assistant in chemistry In the Medical Faculty Thomas R Boggs, M D, now associate, to be associate professor of medicine, Charles D Snyder, Ph D, now associate, to be associate professor of physiology, Frank J Sladen, M D, now instructor, to be associate in medicine, William E Burge, Ph D, now assistant, to be instructor in physiology, Karl M Wilson, M D, now assistant, to be instructor in obstetrics, Solon A Dodds, M D, to be assistant in obstetrics, Eli K Marshall, Jr, Ph D, to be assistant in physiological chemistry, Isaac R Pels, M D, to be assistant in dermatology; Maxwell Ross, M D, to be assistant in medicine

FACULTY additions and promotions in Adelbert College and the College for Women of Western Reserve University have been made as follows· Harry William Springsteen, assistant professor of physics, to be associate professor of physics, Clinton Raymond Stauffer, Ph.D., associate professor of geology, James K Whittemore, M A, appointed assistant professor of mathematics; Walter Edward Sullivan, M A., instructor in biology. Faculty promotions and appointments in the medical department were made as follows. George Washington Crile, Ph D, M D, formerly professor of clinical surgery, was appointed professor of surgery; Carl August Hamann, M.D., formerly professor of anatomy, was appointed professor of applied anatomy and clinical surgery, Davidson Black, M.B, was appointed associate in histology and embryology.

IN the University of Michigan Museum, Dr. A. G. Ruthven has been promoted to be assistant professor of zoology and head curator of the museum; Miss Crystal Thompson has been made assistant in the museum. In the Department of Zoology, Dr. A. F Shull, of Columbia University, has been made instructor in zoology, in place of Assistant Professor A S Pearse, who has become assistant professor of zoology in the University of the Philippines, Dr George La Rue, of the University of Illinois, has been made instructor in zoology Assistant Professor O C Glaser has been granted leave of absence during the first half of the next academic year

AT Rutgers College instructors have been appointed as follows F F. Couch, M.E (Lehigh), in mechanical engineering, Floyd E Chidester, Ph D (Clark), in biology, and Harry R Lewis, B Sc (Rhode Island), in dairy husbandry

FRANK A. MANNY, of the education and extension departments of the Western State Normal School, Kalamazoo, Mich, has been appointed director of the training of teachers in the city of Baltimore

THE trustees of the University of Pennsylvania at a meeting held on June 12, 1911, advanced Dr John W Harshberger from assistant professor of botany to professor of botany.

DISCUSSION AND CORRESPONDENCE

THE DISEASES OF ECONOMIC PLANTS

THE recent review of "Diseases of Economic Plants" by Dr W A Orton[1] contained statements which I feel impelled to controvert, not in justification of the book, but in order to place the facts in their proper bearing before the readers of SCIENCE, lest some not technically informed should be led into erroneous conclusions by misstatements *ex cathedra*.

Some of his criticisms are merely matters of personal opinion, as, for example, his views on the use of the termination "ose" in naming diseases. This method was first suggested several years ago in a committee report before the American Association for the Advancement of Science, Section G, with Dr. Halsted as chairman. It has been used to

[1] SCIENCE, April 21, 1911, 621

some extent in this and other countries for years, and while some pathologists do not favor it, many others do. Moreover, Dr. Orton himself, in a letter,[2] writing on this point, says, "I would even make use of the new terminology in cases where no other suitable common name is available."

His mention of "more serious errors" deserves attention. Here he objects to considering *Microsphæra alni* as a destructive parasite, saying, "This fungus is one of the least harmful of the pecan parasites." Fawcette[3] quotes Mr. W. A. Munsell, of Florida, as saying that this fungus "had practically destroyed the pecan crop the year before."

Orton says, "The injury to tomatoes from *Phytophthora* is overstated." We stated that "It is very injurious, causing complete devastation of the crop in some sections and resulting in the loss of many thousands of dollars."

Authority for this may be found in the statement of R. E. Smith,[4] a very careful and reliable worker, who says, "During the fall of 1907 the whole acreage of tomatoes was completely ruined in this manner (by *P. infestans*) before active shipment had begun, making the crop a total loss." Also "in the district mentioned the shipments fell off within a very short time, from 2,000 crates a day to practically nothing . . . many thousands of dollars were lost."[5]

Orton himself[6] says of this disease, "Quite common in Massachusetts . . . reported also in southern California, where it caused large losses to the winter crop."

Orton says, "Absurdly large losses are attributed to cotton anthracnose in Georgia."

Our words are:

> The disease is very destructive in some localities and prevails throughout a large portion of the cotton belt. In central Georgia it is said to destroy about 22 per cent. of the crop yearly, sometimes more, while to the state as a whole the loss is put at 17 per cent. or approximately $14,750,000.

I may here quote the following:[7]

> From middle to north Georgia the gradual decrease in per cent. of the crop destroyed is from 22 per cent. to about 12 per cent. and to south Georgia, from 22 per cent. to about 4 per cent. It is conservatively estimated that the anthracnose costs the farmers of the state at least 17 per cent. of the cotton crop. 1,800,000 bales are gathered in Georgia, which represents then, only 83 per cent. of the crop that should be made, the other 368,900 bales representing the actual loss. This valued at $40 a bale would be $14,756,000 loss in money.

De Loach, the author of this statement, in a recent letter says:

> My statistics carefully taken in sixteen counties of the state of Georgia, in 1906 and 1907, and amounting at the least to 2,000 bolls in a locality, prove clearly to me that for those years my figures were quite conservative. I always selected representative localities and fields, and was making the survey for no other purpose but to estimate the actual loss to the growers incurred by this disease. In several instances in Spalding and Hart counties there was 80 per cent. of the bolls infected, but of course not this per cent. actual loss, as many of the bolls were half good and half diseased.

Orton says: "The description of Bordeaux injury is incorrect, as is also the statement that blossoms are killed and the lives of bees endangered."

As to Bordeaux killing bees it must be recollected that apple spraying is the topic under discussion; that the only time bees would be injured is while the tree is in blossom; that when the tree is in blossom arsenicals are almost invariably used in the spray, hence to spray during blossom is, in practise, dangerous to bees.

The description of Bordeaux injury given in the book is drawn largely from the writings of Hedrick,[8] who wrote his description follow-

[2] February 14, 1910.

[3] Fawcette, H. S., Fla. Agr. Expt. Sta. Rept., 1907, LI.

[4] Report Cal. Agr. Expt. Sta., Bull. 203, p. 44.

[5] R. E. Smith, Cal., B. 175, p. 9.

[6] Yearbook, 1905, p. 608.

[7] Ga. Agr. Exp. Sta., Bull. 85, Tech. Ser., 3.

[8] Geneva Bull., 287, pp. 107–108, Nos. 7, 10 and 11.

ing long experience with Bordeaux injury, a personal experience that is certainly far more extensive than that of Dr Orton I quote here a recent letter from Hedrick bearing on this point

> I have just gone over the description you give of bordeaux injury in your "Diseases of Economic Plants" and in my bulletin on the subject I can find nothing whatever to criticize in the statement you make in regard to this trouble I may say that since my bulletin was published, I have had occasion to give a good deal of attention to Bordeaux injury and do not believe that I would now describe it differently than when the bulletin was written My colleague, Professor Stewart, whom of course you know, and who has also given Bordeaux injury a good deal of attention, has just looked over your description and finds nothing to criticize in your discussion of the injury in question

It is gratifying to know that in these "more serious errors" the text of the book does not deviate widely from a basis, founded on exceedingly good authority, authority in some instances, most instances in fact, as trustworthy as that of our critic

Dr Orton was requested to read and criticise the manuscript of our book prior to its publication This he, with apparent willingness, agreed to do The manuscript of a large portion of the book, including most of the part under discussion, was submitted to him and certain criticisms were received, some of which were accepted, some not, according to the judgment of the authors. For all of this the authors are grateful to Dr Orton

That Dr Orton is much more aggressive and much more searching in this recent public criticism, *after publication, than in his private criticisms prior to publication* may, however, be shown by two quotations as well as by many other adduceable facts.

From letter February 16, 1910, "you already have a discussion of the most important non-parasitic diseases"

From review in SCIENCE, April 21, 1911, "The wilt and die back of the orange are omitted, as is the curly top of beet, one of the two most important maladies of that crop"

F. L. STEVENS

SCIENTIFIC BOOKS

The Stone Age in North America By WARREN K MOOREHEAD, A M Two volumes of 874 pp, 7 in by 9¾ in, 17 plates, 4 of which are colored, and 735 figures in the text Boston and New York, Houghton Mifflin Co 1910

This is the most ambitious work yet produced on the prehistoric implements of the United States The book deals almost wholly with this area, although Ontario and a few other sections of the Dominion of Canada are briefly covered Mexico and Central America with their highly developed stone age culture are omitted

The opening chapters deal with the classification of stone implements according to form and material, with quarry sites and methods of quarrying, the making of projectile points and knives, the cached deposits of finished and incomplete implements, and the general distribution of types Stone chipping in America had reached a high degree of excellence, and some of the finer examples from California, Tennessee and Ohio are probably not surpassed in workmanship by those of any section of the world

The author next describes what he calls the celt-hatchet-axe-adze class of implements which includes adze blades of various types and the grooved and grooveless axe They are shown in great variety The remainder of the first volume is devoted to problematical forms Under this general head are figured and described flat stone pendants, perforated tablets, winged ceremonials, "spud"-shaped objects of slate, pear-shaped pendants, discoidal stones, circular discs for paint, stone tubes, and other types Nearly nine hundred of these objects are illustrated from photographs furnished principally by collectors

The second volume opens with a chapter on bird stones and other effigies This is followed by a treatise on the tobacco pipe. Beginning with the early tubular type a large variety is shown ranging through the simple curved and angular forms to the platform and effigy pipes.

The next chapters are devoted to mortars, pestles, metates, mullers, stone dishes used in preparation of foods and paint, and to shell and bone ornaments, utensils, implements and weapons in considerable variety. The bone objects from the Mandan village sites are of special interest as are also the cut and inlaid bear teeth and engraved bones from the Ohio mounds

The native copper implements of the Great Lakes region are well illustrated. The elaborate ceremonial forms from the mounds of Ohio and other sections are of great interest Implements of this metal are principally knives and projectile points, perforated needles, fish hooks, adzes and axes. The ornaments are mainly beads, breast plates and ear buttons Some of the symbolic forms are elaborate, especially those shown in repoussé designs Various tribes in the United States had mastered the early stages of copper working, but they had not discovered the art of casting All the forms shown were made by hammering, annealing, grinding, perforating, cutting or embossing. Sheet mica was also cut into symbolic and ornamental designs similar to those of copper

A few textiles from the dry caves of Kentucky and the Ozark region and from the cliff-house ruins of Utah are described and illustrated The twined woven shoes from the Kentucky caves are unique The specimens shown in general however give but a faint idea of the great variety and beauty of the woven fabrics common among our Indians in early historic times.

The pottery of the United States is treated briefly, types from the various culture areas being shown. Many of the illustrations are from the publications of W. H. Holmes and C. B. Moore The author writes, "In the far north there is no pottery." He forgets the well-made pottery bowls, lamps and cooking pots of the Alaskan Eskimo.

The following chapters are devoted to grooved axes, celts, pendants and other forms in hematite, and also to miscellaneous objects of stone, such as salmon clubs from Oregon and Washington, perforated stone club heads, grooved stones for straightening and finishing arrow shafts, semi-lunar knives of slate, etc

The last two chapters are devoted to the author's conclusions which are grouped under several headings He acknowledges his indebtedness to forty individuals who contributed plates, figures, or to the text, or who allowed the use of published material. The most important of these original contributions is the excellent bibliography of forty-one pages by Dr Charles Peabody.

The "Stone Age in North America" is written primarily for collectors and the general public, but anthropologists will find much of interest in its pages.

The author's view point of American archeology is best shown by the following quotation from the opening chapter.

> It seems to me that the study of all these learned individuals, the results of which are set forth in the Indian "Handbook" [Bureau of American Ethnology], has led many of them to consider prehistoric life in America as nearly the same as the life of our Indians for the past one or two centuries. I can not believe that the arts of the past are the same to any appreciable extent as those which obtained at the time of the Lewis and Clark expedition

Again in the closing chapter, referring to certain New Jersey archeologists, he writes:

> They understand conditions as they existed in ancient times, and that is something that few men of to day grasp. It can not be learned from reading the reports, from studying in museums, or through obtaining a degree from one of our universities

The failure to comprehend the culture of the prehistoric American Indians except through the study of their stone implements and similar remains is a defect common to many archeologists which is usually apparent in their writings. We can never acquire a comprehensive knowledge of ancient American peoples without first studying existing tribes, and working backward through history, for stone implements alone can teach little without the knowledge thus acquired.

Charles C. Willoughby

A Concise History of Chemistry By T P HILDITCH. Pp 263, 12mo New York, D Van Nostrand Co 1911

This little treatise is an attempt to lay before students of chemistry a condensed summary of chemical history In many respects it is likely to be a useful book, although its conciseness is often an obstacle to intelligibility. Its use demands a rather wider range of knowledge than the average student is likely to possess The chapter upon the earlier history of chemistry, and the evolution of the science, covers familiar ground, but with much omission of detail, the chapters dealing with more specific subjects are very unequal in value The author is an organic chemist, and therefore the chapter upon organic chemistry is remarkably full and well handled It includes a number of tabular statements illustrating classes of compounds, which will doubtless be found valuable for reference The chapter on inorganic chemistry is much less satisfactory, and hardly up to date Apart from a brief reference to the use of the rare earths in incandescent lighting, there is little or nothing relative to the modern utilization of the less common metals, and the paragraph dealing with synthetic mineralogy is even misleading Physical chemistry receives rather better treatment, but even here the phase rule is given inadequate space and in the index it is credited to Wolcott Gibbs This error, which may be due to the indexer rather than to the author, is one of several indications that Mr. Hilditch is unfamiliar with American work. For example, Classen is credited with the introduction of electrolytic methods of chemical analysis, an advance which was really initiated by Wolcott Gibbs, and to which Edgar F. Smith has been a chief contributor So also, although Richards is barely mentioned on page 202, his name is omitted from the tabular statement of atomic weight methods which follows. In spite of these defects the volume may be serviceable to advanced students.

F. W. CLARKE

An Introduction to the Chemistry of Paints. By J. NEWTON FRIEND, Ph D, D.Sc New York, Longmans, Green & Co Pp 204, 8vo

This book is designed to present this subject to those who have had no training in physics or chemistry, and may be regarded as an unqualified success It makes no claim to be encyclopædic, and yet one finds terms and descriptions not given in much larger works

One or two errors have crept in, such for example as the saponification numbers (p. 126) being given as 19 3, etc, when they are ten times as large another is the position of the thermometer bulb in Fig 16 which is much too low

It is an excellent book and may be cordially recommended to all desiring information in this branch of technology

A. H GILL

THE WORK OF THE MARINE BIOLOGICAL STATION OF THE U S. BUREAU OF FISHERIES, AT BEAUFORT, N C, DURING THE YEAR 1910

A NUMBER of the investigations of the preceding year were continued and several new lines of work were begun The equipment of the laboratory was maintained and a number of additions were made to the same. A launch, operated by two gasoline engines, was substituted for the steam-launch formerly used The new launch is of small draft, which feature enables it to be used for dredging and for other operations in the vicinity of Beaufort. In addition to this vessel, the station has been equipped with a motor-boat, a sail-boat and twelve rowboats.

During July and August the laboratory was supplied as usual with electric lights. During the same period a mess was conducted at the station for the use of the scientific staff. The cost of table board for each member was five dollars per week, the same as during the preceding year. The laboratory was supplied with running fresh and salt water throughout the year. The small storage ca-

pacity of the salt-water tank has for several years made it necessary to pump water from the harbor at times when it was unsuited for experimental work. It is possible that a tank of 10,000 gallons capacity will be erected

The library was increased by the addition of a number of publications and by the receipt of reprints, the latter in many cases contributed by the authors

The work on the molluscan fauna, noted in the report for last year,[1] was continued The laboratory now has a nearly complete collection of the lamellibranchs of Beaufort correctly identified and labeled for study and reference The collection includes a number of species collected some distance off-shore by the Fisheries Steamer *Fish Hawk* The identifications were either made or verified by Dr. Wm H Dall, of the National Museum Some progress on the gastropods of the region was made along similar lines

The experimental work on the culture of the diamond-back terrapin was continued and considerable success was attained About 270 young terrapins were hatched during the season, and at the close of the year the whole stock was in a thriving condition A portion of the terrapins hatched during 1909 showed excellent growth during 1910 Preparations were begun to enlarge the scope of the work, which will include the construction of two additional concrete pounds These pounds will be of permanent service to the laboratory for numerous lines of scientific work, in case they can be spared for other than the original purposes As these pounds are supplied with fresh sea water at each high tide they would make excellent vivariums for keeping marine animals under nearly natural conditions, and they would at the same time be subject to control The terrapin work has been under the general direction of Professor W P. Hay, of Washington, D C.

In cooperation with the U S. Weather Bureau a daily record of the maximum and minimum temperatures and of the rain-fall, as well as of other miscellaneous meteorological phenomena, has been kept This work has been carried on without interruption since the summer of 1905 Some attention was given to the cultivation of the oyster in Pamlico and Core Sounds An inquiry was also made in regard to the character of fossil remains excavated during the process of construction of the new canal connecting Beaufort Harbor with the Neuse River

[1] SCIENCE, May 6, 1910

The facilities of the laboratory were utilized by a number of investigators, either for independent research or for the scientific work of the bureau They have kindly furnished abstracts of their work, which are included herewith

Professor H V Wilson, of the University of North Carolina, carried on an investigation for the bureau dealing especially with the regenerative power of the tissues in hydroids Professor Wilson had shown that when the tissues of certain sponges are forcibly broken up into their constituent cells, the cells will re-unite and form plasmodial masses which differentiate into perfect sponges It seemed desirable to learn whether this power was possessed by the tissues of other aquatic forms The investigation showed that hydroid tissues have this power

Experiments were conducted on two hydroids, *Pennaria tiarella* McCrady and *Eudendrium carneum* Clarke The phenomena were essentially the same in the two forms The cells and small cell masses into which the hydroid flesh is broken up reunite and form masses, the size of which is in a measure under control. These secrete a perisarc As compared with the corresponding masses in certain sponges they are subject to great mortality Some survive and after a few days give rise to hydranths with the characteristics of the species

The inquiry was extended to learn what power of fusion lies in the forcibly separated cells of the alcyonarian, *Leptogorgia*, and in those of the immature gonad in *Asterias*. In each case active fusion goes on between the cells and cell lumps into which the flesh has been broken up, and masses are obtained which acquire a smooth surface. These were

kept alive in laboratory dishes for some days, but underwent no further change

Dr E P Lyon and Mr L F Shackell, of St Louis University, worked upon problems connected with the fertilization of the ovum, directing their attention particularly to the chemical differences between fertilized and unfertilized eggs, using for the most part sea-urchin material

A large amount of material for chemical analysis was collected which is to be worked up in the Physiological Laboratory of St Louis University, also at Chicago through the cooperation of Professor Waldemar Koch, of the University of Chicago

Messrs Lyon and Shackell studied the changes in permeability occurring in eggs resulting from fertilization, and a preliminary article on this work was published in SCIENCE, August 19, 1910

Dr E W Gudger, professor of biology and geology, State Normal College, Greensboro, N C, spent ten weeks at the laboratory beginning May 25

Owing to the difficulty in getting eggs and embryos in May and early June, he was unable to complete his series for the life history of the gaff-topsail catfish He now lacks only the segmentation and the earliest invagination stages He was very successful, however, in hatching the eggs and rearing larvæ

He was also successful in getting about half the stages for the life history of the butterfly ray, and hopes to complete this series next season Some of these larvæ are very extraordinary in form.

In his work with the spotted sting ray, he was fortunate in obtaining three perfect specimens, two of them alive From these it is hoped that certain variations in color, spots and teeth may be explained

Careful photographic records were made of all the material referred to above, and an artist (Mr E A Morrison, Jr., of Baltimore), under a grant from the Carnegie Institution, spent two weeks making drawings, chiefly of early stages of the gaff-topsail catfish

Dr. H. S Davis, of the University of Florida, worked at the laboratory during portions of July and August The time was spent in examining fishes for parasitic protozoa and in observations on the morphology and life history of the parasites found, the work being largely of a preliminary nature to serve as a basis for further more detailed investigations

A total of 26 species of fishes were examined for protozoan parasites In the case of several of the more common species many individuals were examined, but with the rarer species the investigation was often necessarily limited to the examination of one or two specimens Most of the parasites found were Myxosporidia, and of the 26 species of fish examined 14 were found to be infected with these parasites As is usually the case, the gall-bladder was found to be most commonly infected, 13 out of the 14 species showing infection of this organ In 2 species both the gall- and urinary-bladders were infected, but, of course, by different species of Myxosporidia. In a few cases the gall-bladder was found to be simultaneously infected with 2 species of Myxosporidia. In most cases the percentage of infected individuals was high, sometimes reaching 100 per cent This was found to be especially true of the adults which were much more commonly infected than the young of the same species. It is significant that, in the case of those species in which Myxosporidia were not found, usually only one or two individuals were available for examination and these were often immature

In the case of all the species of fish found to be infected no myxosporidian parasites have previously been recorded

The Myxosporidia found belong to 6 genera, as follows, the species in many cases being apparently undescribed *Sphærospora, Sphæromyxa, Chloromyxum, Ceratomyxa, Myxobolus* and *Henneguya* In several cases, on account of the absence of material in the proper stages, it was found impossible to determine the genus

In at least two cases the same species of Myxosporidia was found to occur in two or more species of fish

A large amount of material was preserved with a view of working out the life history of several species as far as possible, and is being worked up as rapidly as time will permit.

The fresh blood of a large number of individuals was carefully examined for trypanosomes or Hemosporidia, but with uniformly negative results

Dr. James J. Wolfe, professor of biology, Trinity College, Durham, N C, spent the months of July and August at the laboratory Dr Wolfe collected material and began studies with a view to publishing a complete life history of *Padina* The microscopic technique was worked out and a beginning made on the cytological side of the problem In addition sixty-six cultures consisting of germinating tetraspores, fertilized and unfertilized eggs, were started in the laboratory on oyster shells and later transferred to the harbor for the purpose of testing by cultural methods the theory of alternation of generation and also the vitality of eggs which germinate parthenogenetically. The cultures which survived were collected and forwarded to Dr Wolfe for examination later in the season Contrary to published notices, female plants were found here in abundance. These bear a close resemblance to tetrasporic individuals—a fact which probably accounts for their having been overlooked Contrary also to published notices, it was found rather late in the season that there is a regular succession or periodicity in the production of the sexual elements.

Dr. H. S. Colton, of the University of Pennsylvania, worked at the laboratory during the spring. During the previous winter at the University of Pennsylvania, Dr. Colton had been working on the morphology and physiology of the pyloric gland of the ascidian, *Botryllus*. This organ is composed of branching tubules with blind endings. These tubules ramify over the walls of the intestine, opening by means of a single duct into the stomach. This gland he has found to have the characters of an excretory organ in *Botryllus*.

While at Beaufort last spring, he was able to extend these observations on to other forms of Tunicates—*Amaroucium, Perophora, Ascidia, Styela* and *Molgula* The result of those observations helped confirm the conclusion arrived at by the study of the organ in *Botryllus*

Dr J M Wilson, of Washington, D C., made collections and preparations of selachian brains for the purpose of comparison with the teleostean brain, especially that of *Ameiurus*

Mr. W H Kibler, of Guilford College, collected material for the study of the origin of the sex cells of fishes. Consecutive stages in the development of the toadfish were obtained, together with certain stages from the blenny and *Fundulus*.

Mr L. F Shackell, instructor in physiology, St Louis University School of Medicine (in addition to his collaborative work with Dr. Lyon), collected considerable material for a study of the nutritive value of the edible crab, *Callinectes sapidus* A study is also being made on the chemical changes taking place in *Callinectes* during the moulting period. Most of the analyses are being made in St Louis

Mr Peter Okkelberg, of the University of Michigan, studied principally fishes and fish parasites. Most fishes were found to be infested with parasites and collections were made for future study.

A general study was also made of the local fauna Note was taken of the distribution and habits of the different forms, with special reference to their adaptation to environment. Ample opportunity was furnished for the study of live animals under control. The structure and development of many forms were also studied.

Protozoans, jellyfish and larvæ of different kinds were obtained by towing, and a study was made of the material brought up by the dredge in various parts of the harbor. The extensive shoals and beaches were frequently surveyed and all the material found was studied as far as time permitted.

Mr. Raymond Binford, Johns Hopkins University, continued the study of the life histories of the crabs of Beaufort, especially that of *Menippe mercenaria* By a later study of the material killed and preserved during the summer, the processes of fertilization and gastrulation in this crab are being worked out.

In experiments in which eggs were subjected to differences of temperature, those which were kept a few degrees above normal hatched nine days after they were fertilized, while those kept below the normal hatched on the thirteenth day after fertilization

Some twelve hundred of these crabs were caught in the waters about the Beaufort harbor during the summer

Mr J D Ives, instructor in biology, Wake Forest College, made observations on the regeneration of nemerteans and *Amphitrite* during the month of August Sections of nemerteans were found to regenerate readily The anterior surfaces of the sections were found to regenerate but a small amount of new material compared with that formed by the posterior surfaces The posterior surfaces of the sections regenerated rapidly In about four weeks, sections of worms not over one half inch long were found to more than double their length with new material

The tentacles of *Amphitrite* when pulled off were found to regenerate readily In about ten days or two weeks after removal, the tentacles attained nearly an inch or about half of their normal length When the entire tentacle bearing somite is cut off, the worm lives almost as well as when only the tentacles are removed When the somites bearing both the tentacles and the first pair of branchiæ were cut off, some few specimens lived for over two weeks.

HENRY D ALLER

THE BIOLOGICAL EFFECTS OF RADIUM[1]

AMONG the first discoveries made after the production of concentrated radium salts was that radium is capable of causing intense effects upon living tissues. We were not unprepared for such a discovery in the case of radium because similar phenomena had been observed early in the study of X-rays. In the case of X-rays the discovery had been totally, and very unfortunately, unexpected The early burns from radium were of the same character as X-ray burns, and later detailed study has shown that the effects upon tissues of the two agents are practically identical An appreciation of this fact is useful at the outset of a consideration of the biological effects of radium, it gives one at once a large number of analogous facts that have been well studied and, because of the more extensive study that has been made of the biological effects of X-rays, enables one to correlate more satisfactorily some of the isolated observations upon the actions of radium Because the gross effects of radium, which furnish us many valuable facts, can be studed in the skin, and because the effects upon the various tissues of the skin give us the most comprehensive view of the biological effects in general of radium, it is conducive to clearness to consider first the effects of radium upon the skin, meaning by the skin in this connection the human skin or skin of similar structure of other animals

When the human skin is exposed for a sufficient length of time to an active radium salt a peculiar and definite reaction is set up, of which the first striking feature is that it does not develop until after a relatively long period of quiescence—as a rule about two weeks In a skin containing a considerable amount of pigment, there is first an increase of pigment, shown by an ordinary "tanning" of the exposed surfaces. If there are any freckles or pigmented spots in the exposed area, these become darker. Along with this pigment stimulation there occurs a reddening of the skin, with a feeling of irritation and burning such as one has from sunburn. The reaction may stop at this point and after a few days gradually subside, the redness and irritation diminish, there is some scaling from the surface and in a few days more no evidence of the reaction remains,

[1] Address before the Illinois State Academy of Science, Chicago, February 18, 1911

except the increased pigmentation which is very slow to disappear.

In this reaction we have had simply the familiar picture of sunburn. But the process, in many cases, goes much further, and then there occurs a reaction which is peculiar to X-rays and radium. After the development of an inflamed, reddened area of skin the surface becomes intensely congested, purplish, and then blisters form. At the same time, or before, the hairs loosen and fall out. Next the blisters rupture and leave a surface covered by a necrotic pellicle, like a diphtheria membrane. And the reaction may go still further, with the formation of an ulcer whose striking characteristics are its painfulness and its extreme indolence, showing, it may be for months, no tendency to regeneration. The process may stop at any of the stages described above. If subsidence occurs short of ulceration the skin may again become normal, but after the severe reactions without ulceration, and after ulceration when healing takes place there may be very distinct permanent changes in the skin. The hairs grow sparsely or not at all; the pores are very fine or absent, from destruction of the glands of the skin. The skin is thinned, with here and there roughened horny points or patches up to the size of a finger nail, and the surface is reddened from numerous dilated capillaries which show through the thinned horny epidermis.

We have here, as a result of these powerful forms of radiant energy, a picture of extreme interest. The condition is in fact an exact, sometimes an exaggerated, picture of the atrophic senile skin, with its dilated blood vessels and senile keratoses. As a matter of fact the picture is so nearly that of senile skin that I was able, in the case of X-ray lesions, to predict that cancers of the skin would be found to develop in them because the keratoses of old age are so frequently the starting point of cancers. It would take us too far from our subject to give all of the reasons for the idea, but the identity of chronic radium and X-ray changes in the skin with those of the senile skin, strongly indicate that the senile changes of the skin are in good part the result of the less powerful action over a long period of years of sunlight. Another fact, that is beside our topic, is highly interesting in this connection. Cancers develop in the keratoses of X-ray and radium dermatitis, and in them we have one form of carcinoma which is directly traceable to its exciting cause, and only by bringing in a *deus ex machina* in the form of later infection can one avoid the conclusions that at least in these lesions we have cancer which is not of microbic origin.

When radium is applied to various pathological lesions in the skin the same phenomena occur that are seen in healthy skin, with the addition that under proper precautions selective destructive effects may be produced upon the diseased tissues. Take, for illustration, nodules of tuberculosis or of carcinoma or sarcoma (cancers) in the skin. With proper care in grading the applications a reaction may be produced which will cause these tissues to be entirely destroyed, while this reaction is not sufficient to destroy the normal stroma in which they are situated, or, if it does destroy the normal tissues in the involved area, they will regenerate with the formation of healthy scars. It is also found in itching and painful conditions of the skin that the applications have a definite anesthetic effect.

The microscopic changes in tissues undergoing a radium reaction are even more interesting than the gross changes. In the early stages of radium irritation sections show evidences of proliferation of the tissue elements, such as indicate an over-stimulation of the cells by a peculiar irritant. These changes are most marked in the tissues of the greatest functional activity. At first there are an increased production of pigment, and an exaggerated proliferation of the germinal and younger (deeper) cells of the epidermis, especially of the cells of the follicles of the epidermis, in the corium or body of the skin, there are dilatation of the capillaries, an infiltration of round cells, and œdema—the changes of inflammation. Later the changes become exaggerated: there is proliferation of the inner layer of the blood vessels (an ob-

literating endarteritis), the round-cell infiltration becomes intense, the connective tissue fibers are œdematous and stain poorly In the epidermis the cells show extreme degenerative changes, they become vacuolated, the nuclei are fragmented, there is degeneration of the cytoplasm so that stains are taken poorly, and complete breaking down of many cells. These changes are especially intense in the highly specialized and active cells of the appendages of the skin—the hair follicles and the sweat and sebaceous glands—and they may result in the obliteration of these structures, a phenomenon which, occurring as it may without destruction of the surrounding tissues, is not produced by any other known agent In the last stage in a radium reaction there is necrosis of all of the affected tissues, the connective tissue stroma being the most resistant and last to break down In diseased tissue of the skin such as epithelioma (cancer) and lupus (tuberculosis), there is the same sort of reaction, it is also found that the pathological tissues which are composed of growing cells, often of embryonic type react in the same way as the active sensitive tissues of the normal skin. They are more sensitive to the effects than the stroma in which they are growing, disintegrate or degenerate readily, and are destroyed before or without destruction of the connective tissue around them

It is evident in this process that we are dealing with an agent whose results are produced by influencing the biological processes of the cells themselves The effects are not produced by an immediate destructive action of the rays, as a heat burn, for example, is produced There is no immediate effect from the application of radium, it is only after days, it may be two or three weeks, that the effects appear The inference is that the radiations set up some process in the tissues which itself ends in their destruction. The whole process is one of exaggerated stimulation of the activity of the cells of the tissues a stimulation which varies in degrees with the degree of specialization or functional activity of the different type of cells In its slightest degrees it is the ordinary protective process that occurs under exposure to sunlight, but under the unusual and extreme irritation of this artificial form of radiant energy the reaction becomes destructive

Since the effects of radium have had therapeutic application, it may be interesting to pause to consider briefly this aspect of the subject

As I have suggested, the effects of radium to a degree are selective in that they excite the intensest reaction in the cells of great functional activity whether this be in the exercise of a special function or the simpler function of growth Thus there is produced by radium (1) A stimulation of the cells, (2) an exaggerated effect upon the highly specialized structures of the epidermis, viz, the hair follicles, and the sebaceous and sweat glands, and likewise upon the basal or germinal layer, (3) an endarteritis or proliferation of the lining membrane of the blood vessels which may lead to obliteration of many blood vessels, (4) destruction of masses of diseased tissues, which are composed of young growing cells or immature cells

These effects upon tissues suggest the possible use of radium for various therapeutic purposes, as follows (1) To stimulate chronic processes This principle has been successfully used in the treatment of some chronic inflammatory processes in the skin (2) To destroy or diminish the follicles of the skin, particularly the hair follicles This principle has had practical application with X-rays, but because of the small quantities available, not with radium, except in the case of hairy nævi (birthmarks) (3) To obliterate blood vessels in the skin This has had practical application, with very successful results, in the treatment of vascular nævi (birthmarks) (4) To destroy pathological tissues This use is of course possible of wide application, and has been successful in various diseases of the skin and the adjacent underlying structure, especially in carcinomas and sarcomas (cancers) Its limitation in cancer is that it is only effective upon such

lesions as can be directly exposed. As the action is to a degree selective, radium and X-rays have had very valuable practical uses in these diseases. (5) Finally the anodyne effect of radium has had some application in the relief of itching and of pain.

The therapeutic uses of radium are obtained from the above indications. The indications which might seem to be derived from the effect upon other organisms, especially upon bacteria, yet to be considered, have not increased the practical application of the agent.

Experiments upon other mammals have added little to the facts given above. Experiments on rabbits have shown that exposure to the radiations causes anesthesia in peripheral nerves (Beck), confirming a fact established by clinical experience. Danysz and Bohn have shown that the nervous system of certain young animals is peculiarly sensitive to the effects of radium, exposures so arranged as to reach strongly the cerebrospinal axis causing paresis, ataxia, convulsions and death. These phenomena, with negative controls, were elicited in mice, which proved most sensitive, and in guinea pigs and rabbits. The sensibility is very much greater in the very young animals, persists in older mice, but disappears in great degree in adult guinea pigs and rabbits. Similar effects upon the nervous system of man from either radium or X-rays do not occur.

I can not take more than enough time to refer very briefly to the effects of radium upon micro-organisms, upon development and upon plants. The knowledge upon these subjects has been carefully summarized in a paper by Hussakof, of Columbia University, which is readily available.

Several experiments have shown the inhibitive or, under stronger exposures, destructive, effect of radium rays upon various bacteria in cultures—the bacillus prodigiosus, colon bacillus, typhoid bacillus, anthrax bacillus and the spirillum of cholera. These are the only biological findings differing from those with X-rays, and are probably due to the greater superficial effect of the alpha and beta rays because of their very slight penetration as compared with the softest X-rays. They indicate a close similarity, with a difference chiefly in degree, in their biological effects between alpha and soft beta rays and ultra-violet rays.

Similar results have been obtained by several observers from exposures of numerous forms of protozoa. Their growth is at first stimulated, then inhibited, and after intense exposures they are destroyed.

Experiments on various eggs, embryos and larvæ have shown, as would be expected, in these embryonic tissues, a high degree of susceptibility. Growth is retarded, monstrosities develop, and, from prolonged exposure, death occurs.

In plants the results of experiments may be summarized briefly as first stimulation of growth, and under stronger application, retardation or complete inhibition of growth.

This consideration has been directed to the effects of radium rays. As to the emanations, it may be stated briefly that experiments with the emanations upon young mice, upon bacteria, and upon protozoa show results quite like those from exposure to the rays.

There is apparently no difference in kind in the effects upon tissues between the different radium rays. Alpha rays have so little penetration that their effect is expended entirely upon the most superficial tissues, but when they are screened out the only difference in the reaction is one of intensity and depth. Exner, in a repeated experiment, by deflecting the beta rays with an electro-magnet directed them upon one white mouse while the gamma rays fell upon another mouse equidistant from the radium. Fifteen days after exposure, which had been for 18¾ hours, a similar ulceration appeared on the tails—the exposed areas—in both mice. All three forms of radium rays then, are physiologically active. This fact might fairly be inferred from their actinic properties. For the physiological effects of all forms of radiant energy, there seems every reason to

believe, are a manifestation of the same actinic effects that we have long been familiar with in certain inorganic substances Indeed, beginning with the red rays of light at one end of the scale and ending with the hardest X-rays and gamma rays at the other, we find physiological effects differing chiefly in degree and corresponding in intensity with the actinic strength of the respective rays

What the bio-chemical processes are that are set going by radium, or by the more familiar forms of actinic energy, we are in no position to say From experiments with radium upon eggs Schwartz proposed that all of the effects of radium upon tissues were due to decomposition of lecithin Hussakof suggests from experiments of Willcock, Zuelzer and Kornicke that oxygen in some not understood way seems to play a part in the process There is every reason to believe that the process is not explicable by any simple chemical reaction Radium rays do not produce an immediate effect upon living tissues, similar to the reduction of silver salts, for example They have an effect upon the life processes of the cells, and these after a relatively long time produce the results that we recognize as a radium reaction In other words the process is a vital process, and one, doubtless, involving all of the chemical complexity of cell life itself

BIBLIOGRAPHY

HUSSAKOF, LOUIS *Medical Record*, July 20, 1907 Action of radium on plants and animals (full summary and bibliography)

HALKIN. *Archiv f. Dermat und Syph*, 1903, LXV, p 201 (histology)

DOMINICI and BARCAT "Archives des Maladies du cœur, des vaiseux et du sang, 1908" (histology)

DOMINICI. *Archives Générales de Médicine*, July, 1909 (histology).

GUILLEMONT "Archives of the Röntgen Ray," Vol XV, No 3, August, 1910 (Effects on seeds and plants and biochemistry.)

BARLING *Brit Med Jour*, July 30, 1910 (histological effects on malignant growths)

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SPECIAL ARTICLES

ON THE CLASSIFICATION OF SAND GRAINS

PROFESSOR W H SHERZER has just published an important paper containing a classification of sands[1] in which a successful attempt is made to use origin as the primary factor for determining subdivisions I say successful, because I believe Sherzer's classification to be a sound one for the reason that it is a natural one In detail, as he himself says, it requires further amplification, but I believe that its leading features will stand. He distinguishes the following types (1) *Glacial sand type*, (2) *volcanic sand type*, (3) *residual sand type*, (4) *aqueous sand type*, (5) *æolian sand type*, (7) *organic sand type*, (8) *concentration sand type* The first five of these are clastic, the others are non-clastic To the clastic he might have added as number 6 the artificially produced sands (or mechanico-organic) which no classification can afford to neglect, and to the non-clastic might be added, for completeness sake, (9) the granular snow and the firn or nevé, precipitated from the atmosphere, and (10) lapilli of igneous origin, but not pyroclastic With the glacial sand group (1) Sherzer compares those formed by avalanches and rock slides, by rock and mud flows, and by earth movements along joint planes, *i. e*, the familiar fault sand He also adds the sand produced in the manufacture of talus, but this, when not due to mechanical slipping, clearly belongs under his residual type

As thus included, the mechanical abrasion sands glacial, fault, etc, come under the heading of *autoclastic sands*, and the series given by Sherzer, with the addition of the artificial sands, corresponds exactly to subdivisions of clastic rocks which I published in 1904,[2] as shown in the following table, where the corresponding divisions of my

[1] W H Sherzer, "Criteria for the Recognition of the Various Types of Sandgrains," *Bull. Geol Soc America*, Vol. 21, No. 4, pp. 625–662, pls. 43–47.

[2] A. W. Grabau, "On the Classification of Sedimentary Rocks," *American Geologist*, Vol. 33, pp. 228–247, April, 1904

classification are numbered to agree with Sherzer's types. The technical terms for the mechanical types of the second column make for uniformity as well as euphony, while lending themselves readily to compounding

A CLASTIC SANDS

(Exogenetic)

Sherzer's Types of Sands

1 Glacial, etc, sand
2 Volcanic sand
3 Residual sand
4 Aqueous sand
5 Æolian sand
6 (Artificial sand) added

Corresponding Divisions in Grabau's Classification

1 Autoclastic sand or *autoarenyte*
2 Pyroclastic sand or *pyrarenyte*
3 Atmoclastic sand or *atmoarenyte*
4 Hydroclastic sand or *hydrarenyte*
5 Anemoclastic sand or *anemoarenyte*
6 Bioclastic sand or *bioarenyte*

B NON CLASTIC SANDS

(Endogenetic)

Sherzer's Types of Sands

7 Organic sand
8 Concentration sand
9 (Snow and firn sand) added
10 (Lapilli or igneous sand) added

Corresponding Divisions in Grabau's Classification

7 Biogenic sand [a]
8 Hydrogenic sand [a]
9 Atmogenic sand [a]
10 Pyrogenic sand [a]

In my classification of sedimentary rocks, I pointed out that after the determination of the agent, the further subdivision of clastic rocks must be on the basis of texture, and that three textures are to be recognized as of primary importance, namely, (1) *rudaceous texture*, the texture of rubble or material coarser than sand (*i e.*, approximately above 2 to 2 5 mm), (2) *arenaceous texture* or the texture of sand (2 5 to 05 mm) and (3) *lutaceous texture* or the texture of mud, *i e*, rock flour, clay, etc These three types of texture produce rocks, consolidated or unconsolidated, which may be classified as *rudytes*, *arenytes* and *lutytes*, respectively. Rudytes and lutytes are found in each of the divisions in which arenytes are found; we have *autorudytes* and *autolutytes*, *hydrorudytes*, *hydrolutytes* and all the rest, just as we have the various arenytes given above Sherzer too is fully of the opinion that the coarser- and finer-than sand particles should be classified on the same basis as the sand itself

[a] These are not arenytes in the sense used above—*i e*, for clastics only

Non-clastic, granular material constitutes sands, etc, only in the broader or popular sense of the term, while it is quite proper to speak of organic or chemical sands, it is desirable that the technical terms arenyte, lutyte, etc, be restricted to clastic rocks only

Professor Sherzer further subdivides his types on the basis of reworking by some other agent Thus he has an aquoo-residual type in which grains originally of residual (atmoclastic) origin are reworked by water. On the other hand, a residuo-aqueous type is one in which original aqueous sands (hydroclastic) have become weathered under the influence of the atmosphere These two subtypes may be termed, respectively, the *hydro-atmoclastic* and the *atmohydroclastic* subtypes of sands. In like manner the other combinations may occur and we may have *anemohydro-*, atmo- and autoclastic sands, *hydro-anemo-*, atmo-, pyro- and autoclastic sands, *anemo-atmo-*, hydro-, pyro- and autoclastic sands, terms which have at least the advantage of euphony over the English equivalents, such as æolo-aqueous or residuo-æolian But the selection of terms is a minor matter, the important thing being the correct classification on a genetic basis, and this Professor Sherzer has done for sands I am happy to find myself so fully in accord with him, and that in the endeavor to classify materials he has come to substantially the same results that I have reached in approaching the matter from the more theoretical basis of principles of classification

It may perhaps be questioned if the secondarily enlarged æolian sand grains which Professor Sherzer claims as concentro-æolian should be included in this classification, which is essentially one of the material in its orig-

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Issued by

National Bureau of Plant Genetic Resources,

I.A.R.I., Campus. New Delhi-110012

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